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MELVILLE T. COOK, Editor

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MAYFLIES OF PUERTO RICO

Jay R. Traver

The mayfly fauna of this island has not been studied, up to the present time. There seem to be but two references to a specimen of this order from Puerto Rico, in the published literature of the group. The first of these may be found in Dr. Hagen's *Synopsis*, (**9**) pg. 54, under *Cloe unicolor* Hagen: "I have seen a female specimen from Puerto Rico, similar to this, with the thorax fulvo-aeneous: is it a different species?" The second reference occurs in Kolbe's (**13**) *Die geographische Verbreitung der Neuropteren und Pseudoneuropteren der Antillen*, pg. 172: "II. Ephemerida, Von dieser Abtheilung liegt nur ein verdorbenes Exemplar vor, welches vielleicht eine Spezies von Calibaetis ist."

During the spring of 1935, Prof. James G. Needham of Cornell University, and Dean García-Díaz of the University of Puerto Rico. collected many mayfly nymphs and imagos on the island. Later, in the summer of 1935, Dean García-Díaz made many further collections and reared many specimens from nymphs. As a result of this work, twenty species of mayflies, representing six genera in three subfamilies, have been found to inhabit Puerto Rico. An account of these twenty species is herewith presented; three new genera and nine new species are described, along with keys for the determination of imagos and nymphs, and notes on several unnamed species. The designation of the wing veins is that of Tillyard, 1923 (**18**) and Needham, Traver, Hsu, 1935 (**17**).

SUBFAMILY LEPTOPHLEBIINAE

Two new genera of this subfamily are considered to be present in the material from Puerto Rico, each represented by two or more species. Both genera are allied to Hagenulus,—one of these may, in fact, be the true Hagenulus. Since, however, the nymph of Hagenulus is not known, and males of the Antillean species (including

the type species) are unknown or known incompletely, it is considered better to discuss the two Puerto Rican genera under new generic names.

Discussion of the genus Hagenulus and allied forms

The genus Hagenulus Eaton (1882) (**4**), type *caligatus* Etn., from Cuba, was described from female imagos and a male subimago. Genitalia of the male, and wings (presumably of female) are figured, in the Revisional Monograph (**5**). Wings of the female have distinctly margined cross veins; outer fork of radial sector normal,—i. e., with no tendency to sag toward the rear margin; penes of male are straight, rod-like, structures, divided near the base, wholly without spines or bristles. A note following the original description states that four male imagos, "of, perhaps, another species", differing from the male subimago of *caligatus* in numbers of cross veins in costal space, are present in the Hagen collection, from Cuba. These males have spotless wings. In the Revisional Monograph, it is stated that these specimens are females. Dr. Banks (**1**) says that these four specimens are males, and thinks they may be *caligatus*. Another Antillean species of this genus, *H. eatoni* Bks. (**1**), from Haiti, is known from females only. In these, the fore wings are similar to those of *caligatus* Etn., but the hind wing differs somewhat in shape. Three other species have been described in Hagenulus: *monstratus* Etn., (**8**) from Bermuda; *scotti* Etn., (**7**) from Seychelles; and *turbinatus* Ulm., (**22**) from East Africa. Hind wings are figured for two of these species, genitalia for one of them. In two of these (*scotti* Etn. and *turbinatus* Ulm.) the wings of both sexes are wholly lacking in darkened cross veins, but in *monstratus* Etn., dark-margined veins are present in both male and female. The hind wings are not typical of Hagenulus as represented by *coligatus*, in the two species figured. Nymphs of all five of these species are unknown.

Peculiar Leptophlebiine nymphs taken in Cuba (C. F. Baker, J. G. Needham) were described by Mrs. Emily R. Morrison (**15**) as Hagenulus. Cross veins in wing-pads of female nymphs are dark-margined; those of the males have a few spots only. The hind wing somewhat resembles Hagenulus. Mouthparts of the nymphs are peculiar, in that the labrum is much wider than the head. Gills filamentous, each pair bifurcate, the divisions unequal in size. Genitalia removed from a mature male nymph are seen to possess distinct inwardly-directed spines on the penes, much as in Neohagenulus. Are these the nymphs of the genus Hagenulus? If so,

the presence of spines on the penes must be a specific character. Wing-pads of female nymphs are normal as to the outer fork of the radial sector; in the males, however, there is a slight rearward sag in this fork. Other nymphs, taken in Jamaica by Prof. E. L. Palmer of Cornell University, resemble those of Neohagenulus in mouth-parts and structure of gills. The wing-pads of the females are dark-spotted, those of the males are spotless. Outer fork of radial sector normal in females, slightly sagged in males.

Nymphs of the two Puerto Rican genera have been reared, and both sexes are represented. Until *Hagenulus caligatus* Etn. has been reared from nymphs, and males and females correctly associated, so that the type of the genus may be fully known in its several stages, the Puerto Rican forms are held under the names Neohagenulus and Borinquena (new generic names). The differences in the gills of the nymphs seem to indicate clearly that two genera are involved.

Under the genus Borinquena are placed two species, apparently rather closely allied except in the form of the hind wing. In *B. contradicens* n. sp., the hind wing is like that of *Hagenulus caligatus*, but genitalia resemble *B. carmencita* n. sp., the genotype. Thus *B. contradicens* has characters of Borinquena and also of Hagenulus. It is tentatively placed in Borinquena, because of the type of the male genitalia and the gills of the nymph. By structure of hind wing and presence of ovipositor in the female, it would fall into Hagenulus. Gills of nymph filamentous, single, in both species. In fore wing of male as well as of female, the outer fork is distinctly sagged to rearward. No dark-margined cross veins, in either sex.

The three species placed in Neohagenulus resemble one another quite closely. Gills of nymphs filamentous, bifurcate, the two parts of each unequal in size and length. Genitalia somewhat as figured by Eaton for *H. caligatus*, but with distinct spines on the penes. Hind wing reduced in size, but not quite like that of *H. caligatus*. No true ovipositor present, in female. Outer fork of radial sector in wing of male distinctly sagged, almost normal in female. No dark-margined cross veins, in either sex.

Key to Antillean Genera of Leptophlebiinae

ADULTS

1. Cross veins of fore wing of female dark-margined; no spine-like processes on penes, which are slender and rod-like; long ovipositor present.--*Hagenulus*
   Cross veins in fore wing of both sexes without dark margins; a pair of short, spine-like, processes present on penes; ovipositor present or absent---------- 2

2. Outer fork of radial sector in fore wing distinctly sagged to rearward, in both sexes; female with very long ovipositor; long joint of forceps of male almost straight ---------- *Borinquena*
Outer fork of radial sector in fore wing almost normal in female, distinctly sagged in male; no true ovipositor present; long joint of forceps of male strongly bowed ---------- *Neohagenulus*

NYMPHS

1. Gills single, each a slender filament ---------- *Borinquena*
Gills double, filaments of each pair unequal ---------- 2
2. Labrum greatly extended laterally, being wider than head; outer margin of mandible angulate at postero-lateral angle ---------- ? *Hagenulus* (Cuba)
Labrum only slightly wider than clypeus, about one-half the width of the head; outer margin of mandible rounded, convex ---------- 3
3. Wing-pads of female nymph dark-spotted ---------- Jamaican species
Wing-pads of both sexes with no dark spots ---------- *Neohagenulus*

Genus **Neohagenulus** gen. nov.

Small dark-colored mayflies. Eyes of male very large, contiguous apically, almost concealing the pronotum. Median ocellus much smaller than the laterals. Posterior margin of head of female slightly emarginate. Posterior margin of pronotum excavated in median area. Fore leg of male slightly shorter than the body. Femur slightly more than half as long as tibia; tarsus about ¾ the length of the tibia. Basal fore tarsal joint very short; 2nd joint longest, other joints progressively shorter, the fourth about ½ the length of the 2nd. Fore femur of female ⅞ as long as tibia; tarsus about ½ the length of the tibia; distal tarsal joint the longest. In hind leg of both sexes, the four basal tarsal joints are subequal; distal joint about as long as any two of the preceding; in male, somewhat longer than in female. Claws dissimilar on all tarsi.

Fore wing as shown in figure 1. Basal cross veins of costal and subcostal spaces faint; stigmatic cross veins well developed, somewhat aslant. Outer fork of radial sector in fore wing of male distinctly sagged to rearward (less distinctly so in female). Cubital intercalary and first anal veins united at base. Hind wing much reduced in size (fig. 11); drawn out into a sharp point at apex, but this point not bent over. Two well-developed longitudinal veins in wing of male, three in female; behind these, two or three others, faint and incomplete. Several faint cross veins; one at apex well developed.

Forceps three-jointed; long basal joint swollen in proximal half. Forceps base entire. Penes somewhat rod-like; each bears a forward-projecting spine, about ⅓ of the distance from the apex (fig. 3). Apical margin of subanal plate of female with a deep V-shaped cleft. A short egg valve, not a true ovipositor, is borne on the seventh sternite, as shown in figure 7.

Body form of nymph reminiscent of Choroterpes, and very similar to that of Borinquena. Mouthparts as in Borinquena, except that distal joint of labial palp is shorter (figs. 48, 49). Rather long spines on posterior margins of femora; numerous spines on hind tibia, rather generally distributed (figs. 14, 16). Claws pectinate (fig. 46). Short postero-lateral spines on abdominal seg-

ments 3–9; very short on 3–6, longest on 9. Gills double, filamentous; the inner member of each pair is more slender and slightly shorter than the outer one. Each filament contains a single main trachea, often with minute, lateral, branches (fig. 18). Tails three, considerably longer than the body; middle tail longer and slightly stouter than the laterals.

Genotype—**Neohagenulus julio** sp. nov.

KEY TO SPECIES OF NEOHAGENULUS

ADULTS

1. Wings of both sexes distinctly brown-tinged throughout; cross veins prominent ..... *tinctus*
   Wings not distinctly brown-tinged throughout; cross veins less prominent, except along costal margin 2
2. Longitudinal veins in wing of male yellowish along costal margin, elsewhere paler; costal band in wing of female rather dark red-brown ..... *luteolus*
   Longitudinal veins, also cross veins of costal area and apical third of wing, brown; costal band in wing of female pale brown, usually paler toward apex ..... *julio*

NYMPHS

1. Pale areas on head between eyes and ocelli distinctly divided by a greyish black line; spines on fore femur and on hind tibia relatively short (see figs. 15, 17) ..... *luteolus*
   Pale areas on head between eyes and ocelli not divided by a dark line; spines on fore femur and hind tibia longer (see figs. 14, 16) 2
2. Second joint of antenna pale; ventral markings, when present, usually confined to lateral part of posterior margins of sternites 3
   Second joint of antenna blackish, at least in apical half; ventral markings more extensive 4
3. Ventral markings usually absent; abdominal tergites of female largely yellowish ..... *sp. No. 2*
   Ventral markings usually present; abdominal tergites of female largely reddish brown ..... *julio*
4. Body (female) 7 to 8 mm. in length ..... *sp. No. 1*
   Body (female) 6–6½ mm. in length ..... *tinctus*

Neohagenulus julio sp. nov.

A dark brown species, having middle and hind legs pale; entire wing *not* distinctly brown-tinged.

Male imago.—Body 5–6 mm.; wing 5½–6 mm.

Head dark red-brown, (see fig. 21, lateral aspect). Lateral ocelli pearly white, deep red-brown at base. Black, transverse, line along frontal margin; black markings around bases of antennae, between antennae and eyes, on frontal carina and below antennae. Upper portion of compound eyes deep red-brown, lower portion blackish. Thorax dark red-brown; mesonotum and sternum somewhat brighter than pleura and pronotum. Pronotum dark-margined; postero-

lateral angle with heavy black shading; a longitudinal, black, streak, on each side between median line and lateral margin. Mesonotal scutellum blackish; transverse sutures pale reddish, likewise median area directly anterior to scutellum; median area of anterior and middle portion intermediate in color between sutures and remainder of segment. Anterior to wing roots, a wide, whitish, streak margined with black; below wings, another whitish area with dark margins below and to rearward. Dark streaks above coxae on each side. Fore femur reddish brown; black at apex, deep red-brown median streak, black line along each margin. Tibia yellowish, tinged with reddish brown; deep smoky pre-apical area; lower margin blackish. Tarsus pale smoky. Middle and hind legs yellowish; black, apical, band on each femur; dark line along margin of each tibia; apical margin of tibiae tinged with pale smoky. Wings hyaline; very faint brownish tinge along costal margin. Venation deep red-brown. 6 or 7 strong stigmatic cross veins, distinctly aslant; other costal cross veins weak. All veins and cross veins in apical angle of wing heavier than elsewhere. Costa, subcosta and radius margined with dark brown at base; brown shading around bases of other main veins. Hind wing outlined in dark brown. Basal portion of costal margin and of the two main longitudinal veins dark brown. Wings as in figures 1 and 11.

Abdomen blackish brown dorsally, somewhat paler ventrally. Posterior margins of all segments narrowly black. A hyaline whitish dorsal patch on each of tergites 3–8, larger on apical than on basal segments; traces of a black, median, geminate, line on each pale area. A black, longitudinal, streak, usually interrupted, lies halfway between median line and lateral margin; laterad of this, another small, hyaline, whitish, spot, near anterior margin in basal tergites, but lengthened into a pale streak on tergites 6–8; on 8, this streak and the pale, dorsal, patch are confluent posteriorly. Tergites 9 and 10 red-brown like thorax. Hyaline areas on sternites next to pleural fold in antero-lateral angle, and along anterior margins. From the latter area short, irregular, pale, triangles may extend backward into the darker portions of the sternites; anterior half of median line likewise hyaline. Forceps base, penes, and basal joint of forceps reddish brown; distal portion of forceps pale (fig. 3). Basal forceps joint widened at base, suddenly narrowed and bowed near the middle of its length, much as in Choroterpes. Genitalia as in figure 3. A long, slender, spine seems to be present on inner margin of penes (fig. 44). Tails pale, the segments irregularly tinged with smoky; joinings purplish black, alternately wide and narrow.

Female imago.—Body 5–5½ mm.; wing 5–6 mm.

Head very light reddish brown. Dark markings as in male; also a wide, black, band across head between ocelli, another back of ocelli along posterior margin; usually two small, pale, submedian, spots on posterior margin. Basal joints of antennae smoky. Pronotum concolorous with head; wide, black, margins, and a triangular black mark on each side of median line. Mesonotum darker red-brown; scutellum and median line directly anterior to it, blackish. Pleura and sternum largely yellow, the former tinged with red-brown, and marked with black as in male. Legs much as in male; a longitudinal, black, hair-line on each, from coxa to tip of femur. Entire costal space in fore wing very light red-brown, hyaline; wing may be slightly tinged with brown elsewhere. Outer fork of radial sector much less distinctly sagged than that of male; venation deeper in color and more conspicuous. Abdominal tergites with essentially

the same coloring and pattern as in male, but pale areas more or less completely suffused with reddish brown. Usually a pale, lateral, triangle, a narrow, median, line margined with black, and two small, submedian, marks on the anterior margins remain, in tergites 1–7. Pale areas more extensive on tergites 8–10. Sternites yellowish; posterior margins of all very narrowly darkened, that of sternite 1 most prominent. Sternites 2–7 marked as follows. Dark mark or streak in postero-lateral angle; dark line extends laterad of this toward median area, where it is conjoined to the posterior end of a dark submedian curved mark: ( ). Sternite 8 with dark shading around margin of the egg valve. Sternite 9 unmarked. Tails pale brownish; joinings as in male.

Nymph—Head reddish brown; small pale areas before median ocellus and at bases of antennae; a large, pale, area on each side, between eye and lateral ocellus. Vertex and occiput heavily shaded with blackish, leaving four pale, sub-median, spots, those nearer the posterior margin being larger. Antennae wholly pale. Pronotum yellowish; lateral margins and antero-lateral angles blackish. A trident-shaped, blackish, marking in median area, points of trident directed laterad and caudad. Mesonotum yellowish, shaded with black in antero-lateral area and above wing roots. Sternum yellowish. Legs yellow. Femora may be tinged with red-brown; narrow black line at apex of each, and black, longitudinal, hair-line basally on inner surface. Basal fourth of fore femur pale. Basal abdominal tergites of female nymph largely blackish brown; lateral margins yellowish, occasionally also the anterior portion of median line, and narrow, lateral, streaks. Tegrites 4–7 blackish brown, but with more extensive pale markings, located thus: median line (except at posterior margin) and areas on each side of it at anterior margin; oblique, lateral, streaks halfway from median line to pleural fold. Tergites 8–10 largely yellowish; posterior margin brown, likewise a wide, lateral, streak next to pale, outer, margin, and short, submedian, dashes at anterior margin. Posterior margins of all tergites darker. Male nymph has more extensive pale, median, areas on each tergite. Sternites yellowish, sometimes with faint red-brown tinge, most noticeable in male. Posterior margins narrowly darkened, in median area, but with wider and darker mark near lateral margin. Gills greyish, or with yellowish tinge; trachea and its minute branches black. Tails yellow; joinings opaque in young nymphs, red-brown in mature specimens. Tails of a partly-grown nymph are more than twice the length of the body, median tail longer than the laterals.

There seem to be no structural differences between this species and *N. tinctus*, so that it is difficult to distinguish the species represented, from the nymph slough. The slightly larger size and darker ventral markings of the nymph which is here treated as *tinctus*, plus the darkened second antennal joint, serve to distinguish the nymphs of *tinctus* and *julio*. Because of the size and ventral markings, it seems probable that the two species of nymphs treated as *tinctus* and *julio* have been correctly associated.

Holotype—Male imago. Río Cidra, Adjuntas, P. R., Mch. 24, 1935 (J. G. Needham, J. García-Díaz). No. 1398.1 in Cornell University collection.

Allotype—Female imago. Yunez River, P. R., June 21, 1935. No. 1398.2 in Cornell collection.

Paratypes—36 male imagos, 3 female imagos; Río Cidra, Adjuntas, P. R., Mch. 24, 1935; Luquillo Mts., P. R., Feb. 18, and June 9–14, 1935; Yunez River, P. R., June 21–22, 1935 (J. G. Needham, J. García-Díaz). Nos. 1398.3–41 in Cornell collection. Of these, four were reared from nymphs.

Other specimens of imagos were taken from the following localities, during 1935, by Dean García-Díaz. Lares, Guajataca Creek, Mch. 23; Luquillo Mts., June 7–14; Hicaco River, Mch. 7; Yunez River, June 21–22, and Aug. 12–15; El Yunque Trail, June 12, and July 27; Trout's Creek No. 1, June 9; and La Mina Recreational Area, July 14. Nymphs were ollected at Maricao, Mch. 23; Guaynabo River, Feb. 21; Hicaco River, Río Blanco, Mch. 7; Trout's Creek No. 1, June 9; Tallaboa Alta River, Feb. 25; Yunez River, Feb. 27; and El Yunque, Luquillo Mts., Feb. 18 and June 9.

Neohagenulus tinctus, sp. nov.

Distinguished from *N. julio* by the distinctly brown-tinged wings and more prominent cross veins.

Male imago.—Body 5–6 mm.; wing 5½–6 mm.

Head dark red-brown; black markings on frontal margin, at bases of antennae, and around ocelli. Upper part of eyes red-brown (in some of the paratypes, dark purplish brown). Ocelli milky white. Basal joint of antenna blackish at apex. Thorax dark red-brown. Pronotum, mesonotal scutellum, and pleura heavily shaded with black. A paler area anterior to wing roots, enclosed by black shading. Legs as in *N. julio;* however, the dark, apical band on each femur is narrower, less conspicuous. Fore wings distinctly, hind wings faintly, brown-tinged throughout; color slightly deeper in apical third of fore wing. All veins red-brown; those in costal margin of fore wing (costal, subcostal and next succeeding space) somewhat thickened. 8 to 9 stigmatic cross veins, very prominent, somewhat aslant; this area most deeply stained with brown. In holotype and most of the paratypes, all cross veins in fore wing distinct (in *julio,* those back of radial sector usually invisible).

Abdomen as in *N. julio.* In holotype, entire abdomen rather paler, dark bands on posterior margins of segments slightly wider; several of the paratypes are as dark as *julio,* the posterior bands not wider. Tails and genitalia as in *julio* (in both species, slight variations occur in shape of penes).

No apparent structural differences between this species and *N. julio* have been noted, either in the imago or the nymph. Thus, *tinctus* might be treated as a dark form of *julio.* The two species may bear much the same relation to one another as do *Blasturus cupidus* and *Blasturus nebulosus,* among the Nearctic members of this subfamily.

Female imago.—Body 5½–6 mm.; wing 5½–6¼ mm.

Very similar to *N. julio*. Wings distinctly brown tinged; costal band on fore wing red-brown, darker than in *julio*; cross veins somewhat more prominent. Abdominal tergites reddish brown rather than the blackish brown of *julio*. Thus, in the female of *julio*, thorax and abdomen are dissimilar in color, while in *tinctus* these areas are essentially similar. Apical tergites relatively lighter in color than in *julio*, in allotype and some of the paratypes. Abdominal sternites suffused with reddish brown, paler than tergites, but distinctly more reddish than same region in *julio*, thus showing less contrast between dorsum and venter. Dark markings of venter usually confined to the narrow, dark, posterior, margin of each sternite.

Nymph—Very similar to that of *N. julio*, with these differences. Second joint of antenna blackish (dark area confined to apical half of segment, in some specimens). Ventral abdominal markings more extensive; dark, posterior, margins of sternites wider and darker, often bordered by reddish brown shading; entire venter may be tinged with reddish brown. In some specimens, the gills have a faint reddish or purplish tinge.

Holotype—Male imago reared from nymph. Camp Lab. 48, Luquillo Mts., P. R., June 13, 1935 (J. García-Díaz). No. 1438.1 in Cornell University collection.

Allotype—Female imago. Río Cidra, Adjuntas, P. R. March 24, 1935 (J. G. Needham, J. García-Díaz). No. 1438.2 in Cornell collection.

Paratypes—18 male imagos, 34 female imagos. Luquillo Mts., P. R., June 8–14, 1935 (J. García Díaz); Río Cidra, Adjuntas, P. R. Mch. 24, 1935 (J. G. Needham, J. García-Díaz). No 1438.3–54 in Cornell collection. Of these, one female was reared from the nymph.

Other imagos of this species were taken by Dean García-Díaz at the stations listed above; likewise at La Joba Creek, Río Blanco, P. R., Mch. 7, 1935. A speimen from the Luquillo Mts. is dated Feb. 18, 1935. Nymphs were collected at Lares, Guajataca Creek, P. R., on Mch. 22 at Río Prieto, Río Blanco, Mch. 7, 1935.

Neohagenulus luteolus, sp. nov.

Larger and paler than *N. julio* or *N. tinctus*. Wing veins amber or yellowish. Fore tibia of male whitish except tip, femur red-brown.

Male imago—Body 6½–7 mm.; wings 7 m..

Head yellowish. Black markings on frontal area, at bases of antennae, and around ocelli. Upper portion of compound eyes orange. Ocelli milky white. Antennae pale. Pronotum yellowish with reddish tinge; margins, and a curved, lateral, streak on each side, black. Mesonotum concolorous with pronotum; scutellum smoky. Pleura light reddish brown; a wide, blackish, streak anterior to wing roots, enclosing a pale line; black shading below wing roots and around bases of legs. Anterior half of metanotum red-brown, margined posteriorly with black. Posterior half yellowish; black, lateral, spot above leg base.

Sternum darker red-brown. Sutures, and lateral areas of mesosternum behind middle legs, yellowish.

Fore femur rather dark red-brown, with narrow, black, pre-apical, line; extreme tip yellowish. Tibia very pale, yellowish or whitish; a rather wide, pre-apical, purplish black, band, and a dark streak backward from this along lower margin, to about middle of segment. Tarsus pale yellowish; distal joint faintly smoky; a pale smoky streak along lower margin. Middle and hind legs pale yellowish. Two small, black, spots, unequal in size, near apex of each femur, and a faint blackish, longitudinal, hair-line above center of each. A smoky longitudinal streak near middle of hind femur, on some specimens (not present in holotype). Wings hyaline. All veins pale amber to yellowish; those in cubito-anal area often so pale as to be invisible. Cross veins distinct in first three spaces behind costal margin only. 8 to 9 stigmatic cross veins, slightly aslant, are somewhat heavier than others; entire stigmatic area very faintly amber-tinged. Extreme base of costa, to humeral cross vein, thickened and blackish; costal space before this cross vein reddish brown. Costal margin and first vein in hind wing purplish grey at base. Hind wing as in figure 47.

Abdomen pale yellowish or whitish (no reddish tinges except at base and apex), with greyish black, dorsal, markings. Posterior margins of all tergites rather widely dark; lateral area of each likewise deep grey, this dark band enclosing a pale V-shaped mark which does not reach to posterior margin. Median area of each tergite hyaline, wholly whitish except for dark posterior band; outer margin of this pale area curved, ( ). A small black spot over spiracle. Segments 8–10 opaque, tinged strongly with reddish brown. Sternites 1 and 2 likewise reddish brown with smoky tinge; 2 paler than 1; each with two hyaline submedian marks, which are dots on 1, streaks bounding the darkened ganglionic area on 2. Sternites 3–7 pale, hyaline; posterior margins, and a lateral streak paralleling the pleural fold, smoky brown. Tails (missing from holotype) pale yellowish white; joinings black, alternately wide and narrow, the narrow joinings less darkened.

One of the male paratypes differs from the above description thus: head and entire thorax reddish brown, sternites 2–7 with distinct purplish-red tinge.

Female imago.—Head purplish black; two small, pale, submedian, spots on occiput; a pale, narrow, transverse, line between lateral ocelli; pale areas along posterior margin, at bases of antennae, and on outer margin of each lateral ocellus. Antenna yellowish; second joint blackish in apical third. Thorax light reddish brown. Lateral margins, and almost the entire median area of pronotum, blackish. Mesonotal scutellum, and median streak directly anterior to it, blackish. Pleura as in male. Sternum paler than dorsum. Median area, and anterior margin of mesosternum, darker (however, posterior half of mesosternum is pale).

Fore femur dark reddish brown; tibia blackish; tarsus pale, a smoky blotch near apices of 2nd, 3rd and 4th segments, on lower margins; a reddish-black line at apex of distal segment. Middle and hind femora yellowish, with reddish tinge, most evident on hind femur and at apex of each; a longitudinal, black, hair-line extends the length of each; near apex of each, a black spot. Middle tibia deep smoky, hind tibia somewhat paler. Tarsi similar to fore leg, but smoky markings paler. Wings hyaline, brown-tinged throughout. All veins reddish brown. Costal band on fore wing reddish brown, as in *N. tinctus*.

Cross veins somewhat less distinct than in that species, especially behind the outer fork. Wing broader in proportion to its length than in *tinctus*.

Dorsum of abdomen predominantly blackish brown; pale areas yellowish, with faint reddish tinge. Dark dorsal areas much as in male, but more extensive, on tergites 1–7. The pale, lateral, mark surrounded by dark shading is wider than in the male, and curves dorsad apically. The pale, median, areas are smaller than in the male, becoming progressively larger in size from base toward apical tergites. On tergite 8, only small, lateral, areas and a narrow, posterior, margin are darkened, so that the tergite is largely pale. Tergites 9 and 10 are almost wholly yellowish; anterior margin of 9, posterior margin of 10, and lateral margins of each, blackish. Traces of dark, submedian, streaks are visible within the pale median patches, on tergites 1–7. Sternite 1 somewhat tinged with reddish brown; all other sternites yellow; posterior margins very narrowly darkened. Faint dark median markings on sternite 6, and around egg valve on sternite 7. Tails greyish brown; alternate joinings blackish.

In both paratypes, the pale, median, areas on the tergites are much reduced in size, as compared with the above description. (The middle and apical portion of abdomen is missing, in one paratype).

Nymph.—Distinguished from *N. julio* and *N. tinctus* by: 1) the somewhat larger size; 2) the shorter spines on femora and tibiae (figs. 15, 17); 3) the fact that that there is no continuous pale area between eye and ocellus; 4) the *median* dark ventral mark.

Head dark reddish brown, heavily shaded with black between and immediately anterior to eyes. Yellowish areas around antennae, at outer margin of each lateral ocellus, and at inner margin of each eye. Thus, there is no continuous pale space between eye and ocellus. Antennae wholly pale. Median portion of occipital border, and four submedian spots on occiput (the anterior pair of these the larger), are pale reddish. Labrum 2½ times as wide as long; in *tinctus, julio,* 2 times as wide. Thorax as in *julio*. Legs yellowish, distinctly tinged with pale reddish brown. Basal third of fore femur wholly pale. Two black spots, unequal in size, at apex of each femur. Spines on femora and tibiae shorter, much less prominent than in *julio* or *tinctus*. Abdomen of female nymph largely blackish brown dorsally, on tergites 1–8; pale median and lateral marks as in adult; median area of 8 more extensive than on preceding tergites. Tergites 9 and 10 almost wholly pale; lateral margins darkened, also posterior margin of 10. Dorsum of male with larger pale areas, as in adult. Venter of abdomen yellowish. A short, black, median, transverse, mark on each sternite, somewhat anterior to the posterior margin. Tails wholly yellowish, except in mature nymph. Gills with a greater number of short, lateral, branches than in *julio, tinctus*.

Holotype—Male imago, reared from nymph. Camp lab. 46, Luquillo Mts., P. R., June 9, 1935 (J. García-Díaz). No. 1439.1 in Cornell University collection.

Allotype—Female imago, reared. Same data No. 1439.2 in Cornell collection.

Paratypes—2 male imagos, 2 female imagos. Same locality same collector. June 7–14, 1935. No. 1439.3–6 in Cornell collection.

In addition to the three reared species of Neohagenulus, many specimens of nymphs of a distinctly larger size are present in the Puerto Rican material. None of these has been reared. Two different species seem to be represented; these are designated by number only.

Neohagenulus sp. No. 1

Nymph.—Body of female 7–8 mm. in length. Second joint of antenna black. Spines on femora and tibiae relatively long, as in *N. julio* and *N. tinctus*. Pale area between eye and ocellus not divided by a dark line. Head and thorax red-brown. Abdomen of mature female dark red-brown dorsally. On each tergite, dark, submedian, streaks enclose a pale, median, line; a pair of pale, submedian, spots at anterior margin; lateral markings as in *tinctus*. Venter paler red-brown; anterior margins of each sternite narrowly darkened; intersegmental areas pale; an oblique, dark, mark on each side near posterior margin, halfway between median line and lateral margin. A single large female imago, body marked as in nymph, may represent the mature form of this species.

Nymphs of this species were collected at El Rucio, P. R., in 1934 (Dr. Francisco M. Pagán). Other specimens are from Guajataca Creek, Lares, P. R., Mch. 22, 1935 (J. G. Needham, J. García-Díaz); Río Prieto, Río Blanco, P. R., Mch. 7, '35 (Needham, García-Díaz); El Yunque Trail, Luquillo Mts., June 10, '35 (J. García-Díaz). The large female imago was taken at La Catalina, Luquillo Mts., Apl. 15, 1935 (J. García-Díaz).

Neohagenulus sp. No. 2

Nymph.—Body of female 7–8 mm. in length.

Head pale red-brown. Pale area between eye and ocellus not divided by a dark line. Antenna wholly pale. Thorax yellowish to pale reddish brown; dark markings as in the species previously described. Spines on femora and tibiae about intermediate in length between those of *N. luteolus* and the other three species. Dorsum of abdomen in both sexes largely yellowish. Posterior and lateral margins of tergites, and a mark near postero-lateral angle of each, blackish. Venter yellowish. Posterior margins of sternites may be narrowly darkened throughout, or the dark area may be confined to the lateral portion of each.

Nymphs of this species are from Río Cidra, Adjuntas, P. R., Mch. 24, 1935 (J. G. Needham, J. García-Díaz); La Catalina, Luquillo Mts., Apl. 14–15, 1929 (J. García-Díaz); and El Yunque Trail, Luquillo Mts., Feb. 18, '35 (Needham, García Díaz). Other specimens taken by Dr. Francisco M. Pagán at El Rucio, Peñuelas, P. R., in 1934, may be of this species, but are too discolored to permit of certain determination.

Genus **Borinquena** gen. nov.

Allied to Hagenulus and Neohagenulus. Rather small mayflies, wings of the known species 5 to 5¾ mm. in length. Upper portion of compound eyes of male much flattened (fig. 22, lateral aspect). In dorsal view, upper portion

is oval; a small area of lower division is also visible from this aspect. Eyes not contiguous apically, separated by distance equal to width of upper portion. Lateral ocelli very large, median ocellus barely visible. Posterior margin of head of female almost straight between the eyes. Pronotum somewhat excavated in middle of posterior margin. Fore legs of male longer than body; tibia fully twice as long as femur, tarsus subequal to tibia; basal tarsal joint very short, 2nd and 3rd joints subequal, 4th about ⅔ as long as the 3rd, 5th about ⅓ as long as 4th. In hind leg of male, femur slightly more than half as long as tibia; tarsus short, about ⅓ the length of the femur. Hind femur of female three-fourths as long as tibia; tarsus as in male. Claws on all tarsi dissimilar.

Fore wing as in figure 4. Outer fork of radial sector deeply sagged at end of stem, in both sexes. Before the bulla, 3 or 4 weak costal cross veins; beyond bulla, 3 to 5 weak veins before stigmatic area, which contains 7 or 8 well developed, slanting, cross veins. Cubital intercalary and first anal vein joined near base. Hind wing very small, drawn out into a long, slender, point; two longitudinal veins only, no cross veins (fig. 10).

Forceps base entire, bearing at median area of apical margin two short, finger-like, processes (fig. 8). Forceps very distinctive; basal joint very long, somewhat narrowed at apex; the two distal joints subequal, together about equal to ¼ of length of basal joint (fig. 12). Penes elongate, rod-like, usually closely appressed on inner margin; each bears on ventral surface a small, hook-like, projection, well below the apex. A correspondingly long ovipositor is borne by the female, as a development of the 7th sternite (fig. 2). Apical margin of subanal plate of female with a deep V-shaped cleft.

Nymph reminiscent of Choroterpes in proportions of head and body and in general appearance, aside from structure of gills. Mouthparts likewise very similar to those of Choroterpes (see figs. 32, 33, 35, 38, 40). Spines on fore femur longer and fewer in number than in *Choroterpes basalis* Bks; on hind femur, reduced to a relatively few short spines on hind margin (in *C. basalis*, these are more numerous and more widely distributed). Hind tibia likewise with relatively few spines, most of these clustered near apex (in *C. basalis*, these spines are very numerous and generally distributed). Claws pectinate. Short postero-lateral spines present on segments 6–9, that on 9 being longest. Gills single, filamentous; each contains a single, unbranched, trachea (figs. 19, 39). Tails three; median tail distinctly longer than laterals, and slightly longer than body of nymph.

Genotype—**Borinquena carmencita**, sp. nov.

The above characterization of the genus is based on the genotype, and does not hold for the abnormal species *B. contradicens* as regards shape of hind wings and length of male forceps.

Key to Species of Borinquena

ADULTS

1. Wing very much reduced, having but two longitudinal veins, no cross veins; forceps of male very long, equal to combined lengths of last three ab-

dominal segments; abdominal tergites of male yellowish, wings brown-tinged----------*carmencita*

Wing much less reduced, having four longitudinal and several cross veins; forceps of male shorter; abdominal tergites of male whitish, wings not tinged----------*contradicens*

NYMPHS

1. Gills distinctly widened in basal third of their length; abdominal tergites of male yellowish, dark posterior margins narrow----------*contradicens*

Gills tapering more uniformly, not distinctly widened at base; abdominal tergites 7 and 10 of male wholly yellow, 8 and 9 blackish; dark posterior margins of other tergites wide----------*carmencita*

Borinquena carmencita sp. nov.

Wings faintly brown-tinged; abdomen yellowish, dark-banded dorsally.

Male imago.—Body 5½ mm.; wing 5–5½ mm.

Head very dark red-brown; antennae brown; lateral ocelli pearly white; eyes blue-black. Pronotum yellowish brown; lateral margin and postero-lateral angle dusky. Anterior margin of prothoracic pleura blackish; an oblique streak across central portion. Mesonotum rather dark red-brown; anterior lobe deep orange; posterior half of median line, including middle of scutellum, and oblique, lateral, extensions forward from median line to wing roots, yellowish. Pleura pale red-brown, yellowish around leg bases. Wide, purplish black, stripe extends forward from wing roots; blackish markings below wings and near leg bases. Metanotum olive brown; posterior margin and scutellum dusky. Sternum red-brown, darkest across anterior portion of mesosternum. Coxa and trochanter red-brown. Fore femur deep purplish brown, with prominent yellow, pre-apical, band; pale brown at base. Middle and hind femora similar, but distinctly yellowish at base. Tibiae dark olive brown, with faint red-brown tinge. Fore tarsus similar to tibia but paler. On middle and hind legs, basal and distal joints of tarsi yellowish, intermediate joints light red-brown, joinings very narrowly yellow. Wings hyaline, iridescent, faintly brown-tinged (figs. 4, 10). Venation dark red-brown.

Abdomen yellowish, semi-opaque. Tergites 1–6 with wide, purplish black, posterior, margins, these bands widest at middle and at each end; at median line, a pale streak may divide the anterior half of this dark border. Anterior extensions from each end of this dark band form an elongate, dark, oval, mark enclosing a pale area; its sides are two dark lines parallel to the pleural fold, conjoined at each end, and extending forward almost to the anterior margin. The dark oval is not well defined, on tergite 6. On tergite 7, the dark posterior band is narrower, and has no lateral extensions; a round, dark, spot is present near the postero-lateral angle, another at spiracular area; on some specimens, a smaller, dark, dot may occur between these. Dusky shading also occurs along the anterior margin of each intermediate tergite, usually as small patches on each side of median line. Geminate, dark, mid-dorsal, streaks are faintly indicated on some specimens, most distinct at each margin. Tergites 8 and 9 largely deep purplish brown; anterior margin of 8, area adjoining posterior margin of 9, traces of median streak, and wide, lateral, margins are yellowish.

Tergite 10 yellow, with reddish tinge. Sternites 1–7 with posterior margins faintly dusky; sternites 8 and 9 tinged with light red-brown. Tails dark olive brown with reddish tinge; joinings darker. Genitalia as in figures 12 and 37. Forceps base light red-brown; forceps dusky, darker at apex of long joint.

Specimens taken on June 7, in the same locality as the holotype, appear much darker; pale bands on femora more or less obscured; posterior dark borders on abdominal tergites more extensive; thorax deeper red-bown; wings more strongly brown-tinged; all markings more intense in color. No structural differences are noticeable. Nymphs of these darker forms are not known, hence it its not possible to determine whether these represent another closely-allied species, or are merely darker forms of the same species.

Female imago.—Body 5½ mm.; wing 5¾ mm.

Very similar to male, aside from usual sex differences. Mesonotum paler brown than in male; a V-shaped yellow mark and an antero-lateral extension of this on each side, anterior to scutellum. Wings as in dark form of male. Abdominal tergites 1–5 largely obscured by blackish shading, leaving on each side a pale, rounded, spot; antero-lateral angles, a narrow, median, line in anterior half, and submedian streaks on each side of dark geminate lines, likewise pale. A wider, pale, band across central area of tergite 6, in dorsal portion. Tergite 7 almost wholly yellowish except for lateral, dark, oval, mark and narrow anterior and posterior margins. Tergites 8 and 9 largely blackish; pale, median, line on each; traces of pale, submedian, streaks at posterior margin of 9; lateral areas of each pale. Tergite 10 yellow. Sternites 7–9 shaded with pale red-brown. Long ovipositor on sternite 7 (fig. 2) extends beyond apex of abdomen for ⅓ of its length; pale yellowish, with dark, longitudinal, streak on each side. Tails somewhat darker than in male.

Nymph.—Frontal portion of head yellow with faint brownish markings. Wide, blackish, band across head between lateral ocelli, usually extending laterad to eyes. Remainder of vertex, and occiput, yellow, more or less obscured by lateral and transverse darker markings, leaving pale posterior margin and a pair of pale, submedian, spots. Thoracic notum yellow; in female, extensive dark markings on median and lateral areas of pronotum, antero-lateral and lateral areas of mesonotum, also dark streaks on each side of central portion of latter segment. In male, these dark areas considerably reduced in size and extent on both segments. Legs yellow; dark markings at middle and apex of femur, in mature nymph. Abdomen yellow, except tergites 8 and 9, which are largely blackish, in both sexes. Posterior margins of tergites 1–6 with wide, blackish, bands. Sternites unmarked. Gills deep purplish grey, tracheae black; more or less uniform in width throughout, *not* distinctly widened at base (fig. 19). Tails yellow, somewhat opaque at joinings. Postero-lateral spines present on segments 6–9; very small on 6, largest on 9.

Holotype—Male imago. El Yunque, P. R., Feb. 18, 1935 (J. G. Needham, J. García-Díaz). No. 1399.1 in Cornell University collection.

Allotype—Female imago. Luquillo Mts., P. R., June 7, 1935. No. 1399.2 in Cornell collection. Same collectors.

Paratypes—56 male imago, 2 female imagos; El Yunque River, P. R., Feb. 18 and June 7, 1935, and Luquillo Mts., P. R., Feb. 17, 1935. Some collectors. No. 1399.3–57 in Cornell collection.

A single male submago was reared, thus establishing the correct association between nymph and imago. Specimens of this species were taken also from the following localities, during 1935 (J. García-Díaz): Hicaco River, Río Blanco (Meh. 7); and Río Cidra, Adjuntas (Meh. 24).

Borinquena contradicens, sp. nov.

Resembles the type species of this genus in the rearward sag of the outer fork of radial sector and in the genitalia of the male, but with hind wings similar to those of *Hagenulus caligatus* (fig. 50). Female with long ovipositor (fig. 34). Nymph quite like that of *B. carmencita*. Abdomen and legs of male imago whitish; thorax and fore femur red-brown.

Male imago.—Body 5 mm.; wing 5½ mm.

Head blackish brown. Compound eyes deep purplish black in upper portion. Purplish shading on basal joints of antennae; filament silvery white. Thorax largely red-brown. Pronotum, wide strip from wing roots to pronotal margin, and pleura of pro- and mesonota, quite heavily shaded with black. Scutellum, area anterior to and laterad of it, and posterior half of median area of mesonotum, yellowish. Metathorax yellowish; purplish black markings on pleura and around wing roots and leg bases. Posterior half of mesosternum likewise yellowish.

Fore femur red-brown. Tibia and tarsus of fore leg, and entire middle and hind legs, pale yellowish white. A purplish black patch at apex of fore tibia. Apices of middle and hind femora pale reddish yellow. Purplish grey, median, patch on hind femur only. Wings hyaline; both wings red-brown at extreme base (in hind wing, largely in costal strip). Longitudinal veins very pale yellow in upper half of fore wing; in remainder of fore wing and all of hind wing, silvery white. Cross veins fine, silvery white; almost invisible except in stigmatic area. Nine to eleven cross veins in this area; slightly aslant, yellow-tinged, and more distinct than cross veins elsewhere. Outer fork of radial sector in fore wing sagged prominently to rearward. Hind wing shown in fig. 50, 50 B.

Abdomen whitish; middle segments hyaline, basal and apical ones opaque. Posterior margins of tergites 3–10 narrowly purplish black, widest at median line; on 3 and 4, dark in median area only. Oblique, lateral, streaks of the same dark color extend the length of the segment on tergites 7–10; on 5 and 6 these streaks may be incomplete at apical margin; not present on basal segments. On tergites 2–8, a purplish black, stigmatic, dot; short, black, marks from the ends of the posterior dark bands extend obliquely above these dots on tergites 4–8. A small, dark, spot on median line above the apical margin, on tergite 5; a larger, dark, blotch on antero-median area of tergite 9. Sternites unmarked. Genitalia as in figs. 36, 41. Tails silvery white; a purplish-black ring at each joining.

Female (subimago ready to transform, cuticle partially removed). Body 3½–4 mm.; wing 5 mm.

Body largely red-brown. Head and eyes blackish. Pronotum and mesothoracic pleura heavily shaded with black. Mesonotal shield and median portion of mesosternum paler, yellowish to olive brown. Tip of scutellum brown. Metanotum yellowish; black markings laterally, especially around bases of legs. Legs (cuticle not removed) red-brown; fore leg darker than hind leg. Purplish, median, blotch on hind femur; apex dark red-brown. Wings (cuticle removed from fore wing) hyaline. Costal space basad of humeral cross vein dark red-brown. Humeral cross vein, costal margin, and subcosta, red-brown; radius and first branch of radial sector same color, but less prominent. Cross veins from costal margin to first branch of radial sector light red-brown, fairly distinct, especially those in the stigmatic area, which are about 9 in number, and slightly aslant. Hind wing red-brown in basal costal space; tip, and entire outer margin, darkened.

Abdomen red-brown dorsally, mottled with black. Median areas of tergites 5–7 yellowish; pale, submedian, streaks on tergites 3 and 4. Posterior margins of all tergites purplish black, the dark band occupying about ¼ of each tergite. Sternites 1–6 pale yellowish, 7–9 tinged with reddish brown. Posterior margins darkened, very faintly across median area, distinctly next to pleural fold. Tails (cuticle not removed) greyish, all joinings black. Long ovipositor present, as in *B. carmencita* (fig. 34).

Nymph.—Body 5 mm. in length. Head yellowish. Irregular, pale brown, markings on frontal portion. A blackish, curved, mark on each side of base of antenna. Antenna yellowish; second joint may be darkened near base. A broad, blackish-brown, band extends across head between eyes, including the lateral ocelli. Posterior to this band, much grey shading; pale areas include a narrow strip behind the dark band, and three pairs of elongate-oval, submedian, spots, those nearest the posterior margin being longest. Pronotum greyish brown, with large, bilobed, yellowish, areas on each side. Mesonotum yellowish. Dark markings along postero-lateral margins; short, dark, submedian, streaks may be present. Blackish shading in antero-lateral areas, extending backward to wing roots. Metanotum yellowish; irregular brown, lateral, markings. Sternum yellowish white. Legs yellowish, in immature nymphs. Traces of dark median and apical bands, on hind femur only, in young nymphs; mature specimens may have dark shading and femoral bands on other legs also. Abdominal tergites 1–3 of female nymph blackish brown; tergites 4–8 same dark color laterally, but each with a large, pale, median area, these pale spots becoming progressively larger in size from tergite 4 toward apex. Tergites 9 and 10 largely yellow; 9 with narrow dark anterior margin. Abdominal tergites of male nymph yellowish, with narrow, dark, posterior, and oblique, lateral, dark markings, as in adult. Sternites of both sexes yellowish, unmarked. Tails of immature nymphs wholly yellowish, or silvery white; mature nymphs similar to adults. Gills distinctly widened in basal third (fig. 39); dark grey, tracheae black. Postero-lateral spines on 8 and 9 (no true processes on other segments) shorter than in *B. carmencita*.

Holotype—Male imago. La Mina Recreational Area, P. R., July 14, 1935 (J. García-Díaz). No. 1440.1 in Cornell University collection.

Allotype—Female subimago, reared from nymph. Luquillo Mts., P. R., June 8, 1935 (J. García-Díaz). No. 1440.2 in Cornell collection.

Paratypes—2 male subimagos, 1 female subimago, reared from nymphs. Luquillo Mts., P. R., June 8–14, 1935 (J. García-Díaz). No. 1440.3–5 in Cornell collection.

Nymphs of this species were taken in the Luquillo Mts. P. R., on Feb. 18, 1935 (J. G. Needham, J. García-Díaz).

SUBFAMILY CAENINAE

Genus *Caenis* Stephens

Three species of this genus are represented, one by a female imago reared from the nymph, one by a female imago and tentatively associated nymph, the other by a single nymph. These may be distinguished as follows.

KEY TO PUERTO RICAN SPECIES OF CAENIS

ADULT FEMALES

1. Five longitudinal black stripes on mesonotum; no dark markings on femur ..... *sp. No. 1*
   A single dark, median, line on mesonotum; two incomplete, blackish, bands and a longitudinal, black, hair-line on femur ..... *sp. No. 2*

NYMPHS

1. Dark area at base of antenna; abdominal tergites largely suffused with blackish ..... *sp. No. 2*
   No such dark area at base of antenna; abdominal markings somewhat more restricted 2
2. Posterior portion of head largely yellowish; numerous small yellow spots on mesonotum; dark markings on apical tergites largely restricted to lateral areas ..... *sp. No. 3*
   Posterior portion of head largely brown; mesonotal markings diffuse streaks; dark markings on abdominal tergites largely transverse bands ..... *sp. No. 1*

Caenis sp. No. 1

Female imago.—Body 3 mm.; wing 2½ mm.

Head heavily shaded with purplish black. Antennae pale. Pronotum greyish, margined and heavily shaded with black. Mesonotum reddish brown, with five longitudinal, black, stripes, one of these on median line. Pleura and sternum yellowish to light reddish brown, darker at sutures. Venation purplish grey. Legs light reddish brown; two black streaks on each coxa, no other markings. Abdomen yellow. Wide, black, bands on posterior margin of each tergite, the blackish shading often extending over half the segment. Tails missing.

Taken at Río Piedras River, P. R., May 23, 1935 (J. García-Díaz).

Two specimens, reared from nymphs. Head and thorax of nymph reddish brown with yellow markings. Black band on head between bases of antennae, another between eyes. Antennae yellowish. Two yellow spots on head, one between bases of antennae, the other along median line of vertex and occiput. Median, dark, band on femur; wide dark band basally on tibia, similar band on tarsus. Anterior margin of pronotum rather widely flaring. Abdomen yellowish with black markings as in adult.

Caenis sp. No. 2

Female (imago removed from subimaginal skin).

Body 4 mm.; wing 3½ mm.

Head yellowish; black shading between eyes. Antennae blackish at base. Pronotum light reddish brown, with much black shading. Mesonotum reddish brown; median line, and streak anterior to wing roots, blackish. Pleura and sternum light red-brown; dark markings on pleura at bases of legs. Black shading on coxa; a black dot on trochanter; two incomplete, blackish, bands on femur, one near base, the other near apex, likewise a longitudinal, black, hair-line along margin. Venation light purplish grey. Abdomen yellowish. Tergites more or less completely suffused with irregular blackish mottling, which on basal ones tends to form dark, posterior, bands. Tails yellowish at base, paler apically; not darkened at joinings.

Río Piedras River, P. R., May 23, 1935 (J. García-Díaz).

A single specimen. A last-stage nymph, about to transform, taken at same time and place, is tentatively associated with this female, because of dark area at base of antennae, the diffuse dark abdominal markings, and the single dark, median, line on the exposed mesonotum of the subimago. Anterior margin of pronotum less flaring than in nymph of *Caenis sp. No. 1;* dark markings on abdominal tergites rather more suffused. Legs missing.

Caenis sp. No. 3

This species is represented by a single nymph, taken at same time and place as other two species. Body more slender than in either of the two preceding species. Head largely yellowish, except for wide, dark, bands between bases of antennae and eyes, narrow continuations from these bands forward to the clypeus, and brownish, lateral, streaks extending forward from the narrowly dark posterior margin. Antennae yellowish. Pronotum mainly blackish, but with a large, yellowish, spot on each side and another on posterior half of median line. A series of small, yellow, spots on the red-brown mesonotum are located as follows: one large spot on each side anterior to wing roots; one large spot laterally on anterior line; four small spots between median line and wing roots; and a pale, oblique, streak on anterior margin at median line. Two small, black, submedian, spots near posterior margin of mesonotum, behind these a pale area. Costal margin of wing pad heavily shaded with blackish. Legs yellowish. Pre-apical black spot and diffuse band on each femur; dark proximal

band on each tibia, another near base of tarsus on fore leg only. Dark marks on pleura above bases of middle and hind legs; small, dark, streak at apex of trochanter on these legs. Abdominal segments yellow; basal tergites heavily suffused with blackish; tergite 10 yellow-brown with no black markings; other tergites pale in median area and along each margin, lateral areas blackish. Tails yellow, not darker at joinings.

SUBFAMILY BAETINAE

The three genera Baetis, Callibaetis, and Cloeodes are represented in this material. These may be distinguished as indicated in the following keys.

KEY TO PUERTO RICAN GENERA OF BAETINAE

ADULTS

1. Hind wing present 2
   Hind wing absent ..... *Cloeodes*
2. Fore wings usually with numerous costal cross veins before the bulla; hind wings with a moderate number of cross veins, the costal projection obtuse ..... *Callibaetis*
   Fore wings without costal cross veins before the bulla; hind wings with no cross veins, or very few of them; costal projection acute, may be hook-like ..... *Baetis*

KEY TO PUERTO RICAN GENERA OF BAETINAE

NYMPHS

1. Gills single on segments 1–7 2
   Gills double on segments 1–6, single on 7 ..... *Callibaetis*
2. Hind wing bud present ..... *Baetis*
   Hind wing bud absent ..... *Cloeodes*

Genus *Callibaetis* Eaton

Females and nymphs of this genus were collected. The nymphs were not reared, hence cannot be associated with the female except by inference.

Callibaetis completa (?) Bks. (2)

Several females taken in September 1930 (Francisco Seín), at the Experiment Station, Río Piedras, P. R., are tentatively placed in this species. The specimens are in rather poor condition, so that it is difficult to be certain of the markings on the body. No dark dots are evident on the thorax. Scutellum of mesonotum, and spine-like median process of metanotum, dark brown. In some specimens, the median area of the mesonotum likewise appears darker than other parts. The second joint of the antenna is slightly brown-shaded, in some specimens. Of this, Banks states: "second joint of antenna mostly dark brown." Legs yellowish, having no dark dots; femoro-tibial joint red-brown; tarsal joinings narrowly dark; claws dark brown.

Wings much as described by Banks: "a broad brown stripe along front margin, covering the first three veins, and on base a little more; this brown fills the costal area to base, and also at tip, it contains a number of transverse hyaline white marks, mostly over veins, very few of these pale spots in the apical fourth". In the basal half of the costal space, however, are many narrow, pale, areas along the cross veins, usually extending from costal margin to subcosta, but sometimes broken up into two pale spots narrowly separated by a brown line. These pale areas usually extend for a short distance beyond the bulla only, but in a few specimens they occur also at the tip. Pale areas around veins in the subcostal space become round spots, except in the apical fourth, where they are narrow as in the costal strip. In the space below radius appear other and larger, pale, areas around cross veins, connected behind with the hyaline portion of the wing. These large pale spots are 5 to 7 in number; the largest occur near the bulla. All veins brownish. Cross veins behind the brown band about 22 in number; none very near the margin. Marginal intercalaries occur singly.

Few or no small, dark, dots on abdomen, but larger, paired, submedian, dark, spots or marks on tergites and sternites; those of the tergites seem confined to the basal and middle segments, and the area between them appears to be darkened. Of *C. completa*, Banks says: "body of usual pale brownish, with many small, dark, dots, especially on the abdomen, beneath with larger, paired, dots, above on the abdomen the basal segments show a large, dark, spot in the middle, tending to form a stripe." Tails whitish; dark-ringed at joinings, the rings of alternate joints wider and darker.

Rather variable in size; wings ranging in length from 5 to 7½ mm. The length of *C. completa* is given as 7½ mm.; type locality, Soledad, Cuba.

Callibaetis sp.

Nymph.—Head and thorax dark red-brown. Pale areas around eyes, antennae and ocelli; vertex and occiput indistinctly mottled, median line pale. Mouthparts normal for the genus. Median line of thoracic notum pale, likewise tip of scutellum and areas anterior to wing roots. Pleura and sternum paler red-brown; darker areas on pleura above leg bases. Legs light red-brown; joinings very narrowly darker. No distinct markings. Abdominal tergites red-brown; intersegmental areas pale, so that abdomen often appears banded. A narrow, yellow, lateral, line half-way to margin extends the length of the abdomen, but is usually concealed beneath the large gills. Pale areas on flattened lateral portion along anterior margin, so that this portion of the abdomen is alternately dark and light. A darker spot at base of each pair of gills. Sternite paler; a wide, median, band, obscurely darker red-brown, extends the length of the abdomen; on each side a row of small, dark, dots, located near anterior margin of sternite. Gills double on segments 1–6, single on 7; large, with lower division of each pair (at least on intermediate segments) almost as large as the upper, and very similar in shape. Tracheation approaching the palmate condition; tracheae purplish black, prominent, numerous. Tails yellowish to pale reddish brown, joinings narrowly darker. A wide, dark, band across tail, formed by an area of long dark hairs.

Body 6–7 mm.; tails 4½ mm.

Specimens were collected during 1935 at Tortuguero Lake, west end, Mch. 9 (J. García-Díaz); Cartagena Lagoon, Feb. 23 and Aug. 10 (J. García-Díaz); Florida Road, Feb. 28 (J. G.-D.); Experiment Station, Río Piedras, May 23 (J. G.-D.). On May 5, 1931, Dean García-Díaz took other similar nymphs at Las Cabezas, Fajardo.

While it is probable that *Callibaetis sp.* is the nymph of *C. completa* (?) Bks., this can be determined only by rearing of the nymphs. In this way, too, it should be possible to obtain the male, and other specimens of females which are in better condition for determination.

Genus *Baetis* Leach

Three species of Baetis are present, one of which has been reared; the other two are represented by nymphs only. Nymphs may be separated as indicated below.

Key to Puerto Rican Species of Baetis

NYMPHS

1. Intermediate gills asymmetrical; each about as long as one abdominal segment plus half of another 2
   Intermediate gills symmetrical; each about as long as three abdominal segments together ..... *sp. No. 1*
2. Gills on segment 7 distinctly narrower and smaller than those on 6; two dark bands on tail ..... *garcianus*
   Gill on 7 very similar to that on 8; a single dark apical band on tail ..... *sp. No. 2*

Baetis garcianus sp. nov.

Male imago.—Body 3½ to 4 mm.; wing 4 to 4½ mm.

Head rather dark reddish brown; antennae and eyes the same color. Turbinate eyes oval, set on high stalks. Thorax dark reddish brown; intersegmental areas of pleura, narrow stripes on each side of mesonotum, and areas around bases of legs and wings, paler. Legs pale yellowish white; coxae largely brown; narrow, dark brown, line at apex of trochanter and at each tarsal joinings. Wings hyaline. Longitudinal veins very faintly brownish in apical and basal portions; wing margin outlined in brown. Costa and subcosta deeper brown at extreme base; a small, dark, spot at base of subcosta and radius. Cross veins colorless. Stigmatic space and parallel subcostal space semi-opaque, filled with granulations. Three or four slanting, stigmatic cross veins, incomplete toward subcosta. No marginal intercalaries in first interspace, or in anal area; between media and cubitus, these may occur singly, elsewhere paired as usual. Hind wing very slender, with strongly hooked, costal angulation, reminiscent of Centroptilum (fig. 9). Two veins only, the first of these usually incomplete at apex; a faint brownish yellow stain at extreme base.

Abdominal segments 2–6 hyaline whitish. Posterior margins of tergites narrowly deep brown, in dorsal portion only; these marks often much fainter at median line. Postero-lateral area of each tergite occupied by a large olive-brown blotch, almost square, but with its anterior margin slightly concave. Antero-lateral areas remain hyaline white. On tergite 2, the upper anterior angle of the dark blotch extends forward almost to the basal margin of the tergite. Dorsum of abdomen thus appears pale in middle area, with a wide, broken, brown, band on each side. Tergites 7–10 deep red-brown, pleural margin paler; sternites olive brown with a faint reddish tinge. Tails white, tinged with yellowish at base; joinings opaque but not darkened. Genitalia as shown in figure 5.

Female imago.—Body 3½–4½ mm.; wing 4¼–4½ mm.

Head yellowish; narrow pale median line on vertex, lateral areas mottled with dark brown. Pronotum dark red-brown; median stripe and lateral areas pale. Mesothorax light red-brown; darker brown markings anterior to wing root; tip of scutellum whitish. Two pale, longitudinal, streaks on sternum. Metathorax dark red-brown. Legs as in male. All veins distinctly brownish; stigmatic cross veins 5 or 6 in number, better developed than in male. Abdominal tergites largely chestnut brown, with creamy markings. These pale areas include the antero-lateral angles, a narrow line along the anterior margin, basal half of median line, short, submedian, dashes from anterior margin, a small dot at end of each dash, and a lateral triangle based on posterior margin. Tergites 8–10 paler than preceding ones. Pleural fold widely pale; small dark stigmatic dots, and a wavy, double, blackish, line along tracheal area. Sternites pale yellowish; dark red-brown shading next to pleural fold, and a transverse, brown, dash in each antero-lateral angle. Tails very faintly brown-tinged at base.

Nymph (described from nymph slough of allotype, with additional notes from nearly-mature nymphs). Head light reddish brown; whitish areas around eyes, ocelli, and bases of antenae; antennae likewise whitish. Maxillary palp two-jointed; labial palp three-jointed, very similar to that of *Baetis sp. No. 1*, shown in figure 25. Epicranial suture and median line of vertex whitish. Thoracic notum concolorous with head; median line whitish; diffuse darker markings and a few creamy areas anterior to wing roots. Pleura and sternum paler reddish brown; brownish semi-lunar markings above leg bases. Legs pale yellowish, femora often with faint brownish tinge; obscure brownish, pre-apical, mark on femur; a distinct dark brown "knee spot"; all joinings narrowly dark brown. Claws amber-tinged; pectinate. Abdominal tergites 1–7 slightly darker brown than thoracic notum; tergites 8–10 paler, 9 and basal half of 10 usually yellowish. All tergites paler next to dark lateral margin. A diffuse pale, median, line on anterior half of each tergite, with obscure darker areas on each side. All margins narrowly darker; posterior and lateral margins of 10 widely dark; postero-lateral angles of all segments greyish brown, with a darker spot at base of gill. Sternites slightly paler than tergites; faint dark, lateral, streaks and obscure, obliquely-directed, submedian, dashes from anterior margin are often evident. Gills single, obovate, those of intermediate pairs asymmetrical (fig. 23). Tracheation pinnate; tracheae purplish black, conspicuous; main branch not extending as far as tip of gill, lateral branches not very numerous. Tails yellowish brown, crossed by two wide, dark,

bands; middle tail about two-thirds the length of the laterals. Body 4½–5 mm.; tails 3–3½ mm.

Holotype—Male imago Tanama River, P. R., March 13, 1935 (J. G. Needham, J. García-Díaz). No. 1400.1 in Cornell University collection.

Allotype—Female imago, reared from nymph. Yunez River, P. R., June 21, 1935 (J. García-Díaz). No 1400.2 in Cornell collection.

Paratypes—23 male imagos, same data as holotype; 4 male imagos, Tanama River, May 12 (J. García-Díaz); 17 female imagos, same data as allotype. No. 1400.3–43 in Cornell collection.

A male and female imago which seem to be of this species were collected at Isabela, P. R., April 24, 1930, and a male at Las Cruces, P. ., April 4, 1930, by Dr. M. D. Leonard. These specimens are in the Cornell collection. Nymphs similar to that from which the allotype was reared were taken during 1935 (J. García-Díaz) at Río Cidra (Mch. 23); Luquillo Mts., (Feb. 18, May 26); Quebrada Tomey (Feb. 21); La Muda River (Feb. 9); Carrera River (Mch. 9); Utuado Road (Mch. 13); Yunez River (Feb. 19, June 22 and Aug. 15; Lares, Guajataca Creek (Mch. 22); Tallaboa Alta River (Feb. 25); Cagüitas River (Mch. 4); Almirante Road (Mch. 9); and Mameyes River (Mch. 8).

The species described by Eaton (**6**), from the Rangel Mts., Cuba, as *Centroptilum poeyi* Etn., is probably a Baetis of the same aberrant type as *B. garcianus*. Abdominal segments 2–6 of *poeyi* are "transparent whitish", unmarked except that "the spiracles and tracheal trunks [are] darker in individual specimens". The narrow, dark, posterior, margins of the tergites, and the lateral, brownish, blotches of *garcianus*, serve as distinguishing features. Were it not that *B. garcianus* was reared from a typical Baetis nymph, it would have been very difficult to decide whether to place this species in Baetis or Centroptilum. Eaton notes: "interneural veinlets of the terminal margin mostly in pairs,"—a condition distinctly reminiscent of Baetis. The hind wing, however, appears to be that of a Centroptilum.

Baetis sp. No. 1

Disconcertingly close to *B. garcianus* in general appearance, but slightly smaller, and differing in the shape and size of the gills.

Nymph—Head very much as in *B. garcianus*. Maxillary and labial palps as in that species; labial palp shown in figure 25. Thoracic notum somewhat more conspicuously marked. Distinct paler areas anterior to wing roots, in-

terspersed with darker markings; on each side of mesonotum an oblique, paler, streak, containing a dark mark, and surrounded by darker areas. Paler mottling laterally on pronotum. Pleura and sternum paler relatively than in *B. garcianus*, the dark, semi-lunar, markings above leg bases therefore more conspicuous. Legs quite similar, but pre-apical band on femur has here become a wider, longitudinal, streak in apical half of the joint, and the dark knee spot is reduced to a narrow line at the femoro-tibial joining. Abdominal tergite 1 and the extreme base of 10 pale; remaining tergites rather uniformly dark red-brown. Marked as in *B. garcianus*, except that the posterior margins are distinctly darker; dark brown shading occurs in a crescentic area based on this margin, or in some specimens as more or less distinct wide, submedian, streaks the length of each tergite; and the pale, median, stripe is practically continuous. Sternites as in the former species, but posterior margins usually obscurely darker. Gills longer, relatively more slender, intermediate pairs more symmetrical, the tips less distinctly rounded (fig. 24). Gill on 7th segment almost as long and as wide as that on the 6th (in *B. garcianus*, this gill is shorter and distinctly narrower than the one preceding), so that its tip may extend beyond the apical margin of the 10th segment. Each intermediate gill is approximately as long as any three of the middle segments of the abdomen taken together. Tails yellowish brown, may be slightly darker at base; in distal half, each joint of lateral tails is darker brown apically, giving the appearance of an obscure darker band near the base, as in *B. garcianus*. Middle slightly more than one half as long as the laterals.

Body 3–4 mm.; tails 3–3½ mm.

Nymphs of this species were taken at the following localities during 1935 (J. G. Needham, J. García-Díaz): Utuado Road (Mch. 13); Luquillo Mts. (May 26); Caño Tiburones (Mch. 12); Cagüitas River (Mch. 4); and Quebrada Tomey (Feb. 21).

Baetis sp. No. 2

Larger than either of the preceding species. One dark apical band on tail.

Body (female) 6–7 mm. Head and thorax pale reddish brown; pale, median, line from frontal suture to posterior margin of metanotum. Pale submedian areas on mesonotum. Darker shading anterior to wing roots. Maxillary palp as in *B. garcianus;* labial palp more like that of *Baetis sp. No. 1.* Legs yellowish. Very faint pre-apical bands on femora; femoro-tibial joint dark brown; claw and tarsal joinings brownish. Tergites 1 and 9 wholly pale yellowish; tergite 4 pale except for brown, anterior, margin and two small, dark, submedian, dots; tergite 10 pale in anterior half, brown posteriorly; tergite 8 largely pale, but with four dark, submedian, marks, one pair on anterior margin, other pair (closer together) near center of tergite. Tergites 2 and 7 dark brown except for pale line near lateral margin; tergites 3, 5, and 6 largely brown, but with pale, transverse, areas, on 5 and 6 a bar near anterior margin, on 3 a more extensive area nearer center. Sternites yellowish white, unmarked.

Gills pale greyish white; tracheae and margins of gills blackish. Tracheae pinnate, intermediate in number of branches between *B. garcianus* and *Baetis sp. No. 1.* Gills slightly asymmetrical, resembling those of *B. garcianus* in shape and relative length. Tails yellowish, with single, dark, apical, band.

Three specimens were taken in the Luquillo Mts., El Yunque Trail, July 27, 1935 (J. García-Díaz).

Discussion of the genus Pseudocloeon Klapalek and allied forms

Three species of Baetine imagos, which by the absence of the hind wing and the paired marginal, intercalaries of the fore wing (these often single, in the females) would fall into the genus Pseudocloeon, are present in the Puerto Rican material. Three specimens representing two species were reared from nymphs. The nymphs possess three tails, almost equal in length and thickness; labial palp apparently two-jointed in one species, ending distally in a pointed projection, in the other species three jointed, distal joint rounded apically; claws without pectinations. The imago of one species corresponds well with characterizations of the type of Pseudocloeon as to relative lengths of leg joints; in the other species, however, the basal joint of the tarsus is very long. Thus these two species differ considerably from one another in characters of both imaginal and nymphal stages.

The genus Pseudocloeon Klapalek was described (**12**) from material collected in Java. The type species is *P. kraepelini* Klap., of which the female imago and the nymph are unknown. Figures of the legs and genitalia of the male of this species are presented by Dr. Ulmer (**23**), along with descriptions and figures of two other species of the same genus. Imagos which correspond to the generic characterization of Pseudocloeon occur commonly in the Nearctic fauna, and several species of these have been reared from nymphs by Drs. McDunnough (**14**) and Ide (**10**). These nymphs have but two tails; both labial and maxillary palps are two-jointed; gills single on all segments; claws pectinate. The two-jointed condition of the labial palp is somewhat deceptive, however, as there are some specimens from North Carolina 3(**19**) in which the fusion of the two distal joints into one is incomplete the palp thus appearing to be three-jointed. In the Cornell University collection, there are several specimens of Baetine nymphs taken in the Philippine Islands which are two-tailed; maxillary palp two-jointed; labial palp more or less distinctly three-jointed, claws pectinate; gills single. These accord well with the reared Nearctic nymphs heretofore assigned to Pseudo-

cloeon. Thus, although the type species of the genus has not been reared, nymphs which correspond to reared Nearctic nymphs are known to occur in the same faunal region as the type locality; imagos of these Nearctic nymphs agree well with the characterization of the genus Pseudocloeon. Until the type species has been reared, I propose to consider the nymphs described from the Nearctic region as representatives of the true Pseudocloeon.

South American nymphs described by Needham and Murphy (**16**) as presumably of the genus Pseudocloeon, prove on further examination to possess hind wing buds; these may be allies of Centroptilum. The nymph of a species described in Pseudocloeon has been recorded from South Africa by Barnard (**2**). This nymph has single gills, present on segments 2–7 only; both maxillary and labial palps are three-jointed; tails three in number, the middle tail somewhat shorter than the laterals. These nymphal characters, together with a tendency in the female imago for the marginal intercalaries to occur singly, (as in the Puerto Rican specimens), leads me to believe that the South African species is not a true Pseudocloeon, but an unnamed genus of the Pseudocloeon group. Another allied genus of this group is Baetiella Ueno (**21**). The nymph of the type species, *B. japonica* Iman., described in Acentrella 4(**11**), was previously described and figured by Ueno 5(**20**) as *? Acentrella sp.* It differs from described Nearctic species of Pseudocloeon only in the possession of a long, slender, filament or hair near the tip of the claw. The imago seems to accord well with the characterization given for Pseudocloeon. Other characters mentioned as separating this genus from allied genera do not seem to be distinctive of Baetiella. Is Baetiella worthy of generic rank?

Structural differences between nymphs from the several localities mentioned, are summarized in the following tabulation. Gills single; on 1–7, unless indicated.

Locality represented	Claws	Max. palp	Lab. palp	Tails
Philippine [1]	Pectinate	2 jts.	3 jts.	2
Nearctic	Pectinate	2 jts.	2 (3) jts.	2
South African [2]	?	2 jts.	3 jts.	3
Puerto Rican [3]	Not pectinate [5]	2 jts.	2 (3) jts.	3
Japanese [4]	Pectinate	2 jts.	3 jts.	2

1—Nymphs in Cornell University collection; no published description.
2—Middle tail slightly shorter than laterals; gills present on segments 2-7 only.
3—Middle tail slightly shorter than laterals, in two species; much shorter, in third species.
4—Genus Baetiella. Long, slender filament near tip of claw.
5—Pectinate, in the aberrant species with very short middle tail; this probably does not belong in the same group with the other two species from Puerto Rico.

The nymphs of two of the Puerto Rican species are seen to differ from all the others in the absence of pectinations on the claws. These nymphs possess three tails, the middle one of these being slightly shorter than the laterals. In still another Puerto Rican species, represented by nymphs only, the claws are pectinate, the middle tail much shorter than the laterals, as in typical Baetis; this latter species is probably not congeneric with the other two, but is here treated tentatively under the same generic name. Since the Puerto Rican species differ so markedly from the Nearctic, Palearctic and Oriental species known, in the nymphal characters of tails and claws, it seems best to place them in a new genus, designated as Cloeodes *gen. nov.* This genus evidently does not include the South African species, which belongs in still a different category.

Genus **Cloeodes** gen. nov.

Turbinate eyes of male extraordinarily large, set on rather high stalks (fig. 20). Eyes of female larger, and set higher and closer together, than in Nearctic representatives of Pseudocloeon. Posterior margin of head of female distinctly emarginate. Fore leg of male only slightly shorter than body. Basal joint of fore tarsus of male very short; second joint longest, about equal to third and fourth combined. In decreasing length, tarsal joints rank: 2, 3, 4, 5, 1. Tarsus almost as long as tibia, which is almost twice the length of the femur. On middle and hind legs of both sexes, basal joint of tarsus very long, exceeding in length the three succeeding joints combined; this joint fully half as long as tibia on middle leg, more than half the length of the hind tibia (figs. 45, 45 A.). Tibio-tarsal joining indistinct. Hind wings absent. Marginal intercalaries of fore wing occur in pairs, which in male are well developed; in female, one member of a pair often indistinct or wholly wanting, so that some marginal spaces have but one intercalary. Cross veins arranged in three irregular series across wing: 6 in apical series, about 12 in middle series. Posterior margin of pronotum almost straight. Apical margin of sternite 9 in female *not* produced backward to form a subanal plate. Genitalia of male as in figure 13. A dome-shaped or slightly truncate "penis cover" is present between the bases of the forceps.

Genotype—**Cloeodes maculipes** sp. nov.

The genus is characterized from the type species. Other species placed in this new genus (*portoricensis, consignatus* and *sp.*) do not agree with the type as to the unusual length of the basal tarsal joint on the middle and hind legs, but conform rather to the type of Pseudocloeon in this respect. The nymphs of *consignatus* and *C. sp.* are unknown; nymphs of *C. portoricensis* are very similar to those of *C. maculipes.* Do *consignatus* and *C. sp.* represent still another genus? And what of *portoricensis?*

Key to Puerto Rican Species of Cloeodes

IMAGOS

1. Narrow longitudinal lines on femora and tibiae, dark spots at apices of fore femur and tibiae; wing 5½ mm. in length ..... *maculipes*
   Legs without distinct markings; smaller species, wing 3–4½ mm. in length 2
2. Wing (female) 4½ mm. in length; no marginal intercalaries in first interspaces ..... *sp.*
   Wing 3–3½ mm. in length; marginal intercalaries in first two interspaces variable 3
3. No marginal intercalaries in first three interspaces; abdominal tergites of female with prominent, lateral, purplish red, spots; male not known ..... *consignatus*
   Marginal intercalaries usually present, though short, in second interspace; abdominal tergites of male and female largely pale, with no such purplish red, lateral, patches ..... *portoricensis*

NYMPHS

1. All three tails approximately equal in length, not dark-banded; claws not pectinate 2
   Middle tail slightly more than one half as long as laterals; tails marked with two dark bands; claws pectinate ..... *sp. No. 1*
2. Small species, body 3–4 mm. in length; labial palp 2-jointed, distal joint as in figure 24 ..... *portoricensis*
   Larger species, body 5 mm. in length; labial palp 3-jointed, distal joint conical, as in figure 19 ..... *maculipes*

Cloeodes maculipes sp. nov.

A creamy white species, with distinctive black markings on femora and tibiae.

Male imago.—Body 5 mm.; wing 5½ mm.

Turbinate eyes very large, set on rather high stalks; upper surfaces almost circular (fig. 20). Stalk deep orange, upper surface pale orange. Head creamy white; faint blackish shading on median line ventrad of lateral ocelli. A broken, reddish, ring at base of antenna; basal antennal joint white; base of filament reddish black, remainder silvery white. Thorax opaque whitish, meso- and metathorax with faint pinkish tinge. Faint brownish markings on antero-lateral areas of mesonotum; scutellum alabaster white. A short, black, mark laterally, directly above base of wing; faint smoky pencilings on pleura, along courses of tracheae. An olive-brown, transverse, band on mesosternum, between middle legs, traces of a similar band on prosternum; ventrad of hind legs, on metasternum, a narrower, blackish, streak.

Legs creamy white; femora and apical portion of tarsi tinged with yellowish. A narrow, black, hair-line extends the length of each femur, on inner surface; a small, reddish, black basal spot on upper surface and a larger preapical one on inner surface; on fore femur, a small red-brown spot at apex.

A narrow, red-brown, line extends the length of the fore tibia; at the apex is a small black spot. Two longitudinal, black, dashes on middle and hind tibiae, one near base, one at center (fig. 45). Tibio-tarsal joining black. Wings hyaline; venation light brown, paler in the wing disc. Subcosta and radius dark brown at extreme base. Paired marginal intercalaries distinct. Cross veins arranged in three irregular series across wing; none near margin. Stigmatic cross veins 3 or 4 in number, simple, somewhat aslant; white next to subcosta, so that they appear incomplete.

Abdomen creamy white. Segments 2–6, also sternites 1 and 7, semi-translucent; tergite 1, and segments 8–10, largely opaque. A narrow, dark, red-brown, line marks the posterior margin of each tergite. Posterior margins of sternites opaque, but not darkened. A black line follows the tracheal trunk above pleural fold on each side; short, lateral, branches extend in both directions from this line. Tails silvery white; in proximal half, joinings narrowly purple-brown, alternately wide and narrow at extreme base. Genitalia as in figure 13. It should be noted that the genitalia of the paratype seem to possess a backwardly-directed truncate process between the bases of the forceps; in the holotype this process is lower and somewhat dome-shaped. Genitalia of both specimens were treated in potash before mounting.

Female imago—Body 5 mm.; wings 5½ mm.

Head and thorax light yellowish brown. A reddish black spot at apex of basal joint of antenna; apical margin of second joint similar in color; both of these joints yellowish. Antennal filament dusky brown, black at base. V-shaped maroon mark on vertex, above median ocellus. Two wide, purplish red, submedian, stripes extend from lateral ocellus to posterior margin of head. Eyes blackish. Posterior margin of pronotum black; purplish red markings consist of: antero-median triangle; small submedian dots; lateral markings, about four on each side. A wide purplish red streak on prothorax behind fore leg; this extends forward on to the coxa; a transverse band between legs, on sternum. On mesothorax, a broken band of purplish red extends forward from wing roots, to anterior margin of mesonotum; below this, at anterior margin, a shorter band of same color; from wing roots to base of middle leg, a longer band. Reddish markings also, around leg bases; laterally on mesosternum; a transverse band across sternum, between middle legs. Ruddy shading on each side of scutellum. Tip of scutellum yellowish. Spine-like process of metanotum purplish red, likewise streaks extending laterad from it. Purplish markings around leg base; a transverse band on sternum, between hind legs.

Legs yellowish. Each femur marked with a basal cross-band of purplish red on upper surface, and a pre-apical band of same color on lower surface. Tibiae marked as in male. Tarsi pale brownish in apical half; joinings narrowly darker. Costal margin of wing, to humeral cross vein, and bases of subcosta and radius, deep purplish red. All veins, and outer margin of wing, brownish; cross veins heavier than longitudinals; 4 or 5 stigmatic cross veins, slightly aslant. Marginal intercalaries as indicated in account of genus.

Abdominal segments 2–7 semi-hyaline, yellowish with extensive purplish red markings; segments 8–10 opaque, heavily shaded with reddish. Posterior margins of all tergites with a wide purplish band; this band reduced to a narrow line on tergites 3 and 4. Tergite 2 largely purplish; a small, pale, spot at median area of posterior margin; lateral pale area next to pleural fold. Me-

dian areas of tergites 3 and 4 almost wholly pale. On tergites 2–7, a wide, oblique, lateral, stripe, deep purplish red in color, extends the length of the segment (on 4, this may be indistinct in posterior half). Pale areas laterally, on all tergites, next to pleural fold; a blackish line follows course of tracheae the length of the abdomen. Sternite 9 yellowish; sternites 6–8 overlaid with red shading. Sternites 1–5 pale yellowish; wedge-shaped, purplish, markings in postero-lateral areas of sternite 1 and 2; traces of same, on sternite 3. Tails missing, except a few basal joints. The two basal joints shaded with purplish red, next two yellowish; wide black band at each joining.

Nymph—(described from slough of type specimen, with additional notes from nearly-matured nymphs).

Head brown, with pale markings. Antennae whitish, at least basally. Pale markings on median and lateral areas of frons: a pale band between eyes and bases of antennae; median line of vertex pale. Maxillary palp 2-jointed, apparently without hairs or spines (fig. 29). Labial palp 3-jointed; distal joint conical at apex (fig. 27). Thoracic notum smoky brown; pale markings on mesonotum anterior to wing roots, the median line pale. Pleura and sternum pale; the former with prominent dark brown semi-lunar markings above base of each leg. Coxa and trochanter pale, often a brown band across coxa. Femur brownish, with wide, pale, longitudinal, streaks at base and apex. Tibia and tarsus pale smoky; in certain lights, a dark, median, band is seen on tibia. All joinings narrowly darker brown. Claws without pectinations. Abdominal tergite 8 largely yellowish; tergites 4 and 7, and basal half of 9, yellowish with brown markings. Other tergites smoky brown; 5, 6, and apical half of 9 often darker than basal ones. A pair of minute, pale, dots at median line, near center of segment, on tergites 1 to 3. Sternites paler than tergites, usually yellowish, more or less distinctly brown-tinged. Brownish shading near pleural fold; posterior margins often narrowly brown. Gills present on segments 1–7; simple, obovate (fig. 42). Tracheation pinnate; blackish, very distinct. Tails three, the middle one only slightly shorter than the laterals; yellowish brown without darker markings. Tufts of very short hairs on each segment (on both sides of middle tail, on inner side only of laterals) appear like stubby bristles.

Length: body 5 mm.; tails 2 mm.

Holotype—Male imago, reared from nymph; Luquillo Mts., P. R., June 14, 1935 (J. García-Díaz). No. 1402.1 in Cornell University collection.

Allotype—Female imago, Trout's pool, El Yunque Trail, Luquillo Mts., P. R. June 12, 1935 (J. García-Díaz). No. 1402.2 in Cornell University collection.

Paratype—Male imago, reared; same data. No. 1402.3 in Cornell collection.

Nearly-mature nymphs of this species were taken during 1935 (J. García-Díaz) in the Sabana River and the Hicaco River, Río Blanco (Mch. 7); in La Coca Creek, the Luquillo Mts. (May 26); and at Guajataca Creek (Mch. 22).

Cloeodes portoricensis sp. nov.

Thorax and tip of abdomen dark red-brown; middle abdominal segments hyaline, white.

Male imago.—Body 3–3½ mm.; wing 3½ mm.

Head red-brown; antennae faintly tinged with reddish. Turbinate eyes very large, prominent; upper surface oval; orange-brown in color, outer rim of upper surface dark brown. Thorax dark red-brown. Mesonotal scutellum and a small spot on each side of it, alabaster white; a similar white patch on scutellum of metanotum. Light tan markings on pleura, near sutures. Legs wholly pale, whitish. Wings hyaline; cross veins practically invisible. Costa, subcosta and radius reddish brown at extreme base; a small brown spot at base of wing. Stigmatic cross veins 4 to 6 in number, simple, somewhat aslant, often incomplete except at the costal margin. Granulations in stigmatic area, extending over apical portions of costal and subcostal spaces, give appearance of a milky cloud. No intercalaries in first interspace; 1 or 2 may be present in second interspace, very weakly developed; in remaining spaces, well developed but rather short.

Abdominal segments 2–6 hyaline, white; joinings opaque. A double, blackish, wavy, line extends along the spiracular area of tergites; a tiny, dark, dot on each line, at spiracle. Tergites 7–10 dark red-brown, but somewhat brighter and paler than thorax. Sternites 7–9 creamy white, faintly tinged with brownish, especially near pleural fold. Tails silvery white. Genitalia as in figure 6.

Holotype—Male imago; Lares, P. R., March 23, 1935 (J. G. Needham, J. García-Díaz). No. 1401.1 in Cornell University collection.

Paratype—21 male imagos, same data. No. 1401.3–20 in Cornell collection.

Seven female imagos, taken in the Luquillo Mts. on Feb. 18, 1935, by the same collectors, may be of this species. Body flesh-colored, head and mesonotum paler than abdomen and remainder of thorax. Abdominal tergites rose-tinged; posterior margins of segments purplish rose on each side of pleural fold, not elsewhere. Longitudinal veins faintly brownish. Othewise similar to males.

Subimago males were taken at Lares, the Guajataca River, on March 22, 1935 (J. G. Needham, J. García-Díaz). The following day, one male and several female subimagos were captured at Adjuntas, (J. García-Díaz).

One male imago was reared, thus making it possible to correlate the imagos with certain strikingly-colored nymphs which had been taken at several stations.

Nymph—Head yellow; faint brown shading on vertex and occiput on each side of pale median line, also above antennae and median ocellus. Antennae pale, faintly darker at joinings. Maxillary palp two-jointed (fig. 30); labial

palp two-jointed, the distal joint expanded into a lobe on the inner margin and terminating in a sharp point (fig. 28). Thoracic notum yellowish brown with darker markings in female, darker brown with pale markings in mature male. A well-marked male show a pale thoracic median line; yellow submedian blotches on posterior margin of pronotum; a trident-shaped pale marking at middle of mesonotum, the points directed forward; a pale band across the scutellum; large, diffuse, yellow, markings between the wing pads, and a few small spots anterior to wing roots. In some specimens, the arms of the pale trident become much widened, so that a large area on each side of center of mesonotum is yellow. Pleura and sternum yellowish. Prominent dark brown semi-lunar markings above bases of legs, and a small, dark, median, spot on anterior portion of mesosternum. Dark, median, and lateral, patches on metanotum. Legs yellow. A small, dark brown, "knee spot" and similar dark spot at tip of tarsus; other joinings narrowly darker. Claws not pectinate.

Abdominal tergites 1, 4, 8 and 10 almost wholly yellowish; tergite 5 yellowish in median area, brown laterally; remaining tergites largely brown, except for round, yellow, median, spot on 2, 3 and 6. Crescentic brown mark on anterior portion of tergite 4; similar but wider mark on 10. Posterior margins of all tergites narrowly dark brown; a small, dark, mark at base of each gill. Sternites pale yellowish; posterior margins of apical segments very narrowly brown. Gills single, obovate, broadly rounded at free end; tracheation pinnate (fig. 43). Tracheae greyish purple, rather indistinct; main trunk often forked near tip, lateral branches few and weak. Tails three, approximately equal in length and thickness. Whitish, with an amber tinge which becomes deeper toward apex. Joinings opaque, faintly amber.

Length: body 3–4 mm.; tails 1½–2 mm.

Specimens of this species were collected during 1935 (J. G. Needham, J. García-Díaz) at the following places: Lares, Guajataca Creek, Mch. 22; Quebrada Tomey, Feb. 21; Río Cidra, Adjuntas, Mch. 24; Utuado Road, Mch. 13; and Hicaco River, Mch. 7.

Cloeodes consignatus sp. nov.

Female imago.—Body 3½ mm.; wing 3 mm.

Head largely suffused with purplish red. Thorax creamy yellow. Lateral and anterior areas of pronotum with extensive purplish red-markings; pleura largely purplish red. Scutella of meso- and metanota, and all elevations of notum, alabaster white. Sternum yellowish with alabaster white markings laterally. Fore and middle legs missing. Hind legs very pale yellow, unmarked. Wings hyaline; longitudinal veins very pale amber; a small, purplish red, spot on humeral cross vein, and brown shading at extreme base of costa, subcosta, and radius. No marginal intercalaries in first three interspaces; none in any space beyond media, usually a single intercalary only in spaces between branches of media; elsewhere intercalaries are normal, paired. Stigmatic cross veins 4 to 5 in number, strongly aslant, usually incomplete toward costa. Abdomen white; segments 1–7 hyaline, 8–10 semi-opaque with distinct yellow tinge. A faint, blackish, double, line extends the length of the spiracular area.

Above this, on each tergite, a prominent rhomboidal purplish red spot; below it, on each sternite, a curved, purplish red mark. Tails missing.

Holotype—Female imago; Yunez River, P. R., June 21, 1935 (J. García Díaz). No. 1403.1 in Cornell University collection.

Cloeodes sp.

Female imago.—Body shrunken; wing 4½ mm.

Head yellowish; posterior margin blackish. Antennae yellow; joinings of basal segments reddish. Thorax yellowish, shaded rather heavily with reddish on pronotum and pleura. Legs yellowish white, unmarked. Wings hyaline, venation very pale brown. Humeral cross vein, extreme basal portions of costa, subcosta and radius, and small area at base of middle veins, reddish brown. Stigmatic cross veins 3 or 4 in number, aslant. No marginal intercalaries in first two interspaces; behind media these intercalaries single or absent. Abdomen heavily shaded with reddish, except middle of venter and dorsum, which are yellowish, hyaline; posterior margins of tergites, and of sternites near pleural fold, reddish black. Two black lines extend the length of the pleural fold. Tails missing.

Taken in Luquillo Mts., P. R., Feb. 18, 1935 (J. G. Needham, J. García-Díaz). It is quite possible that this is the female of *C. portoricensis*, rather than the paler specimens taken on the same date, which are briefly described under that species.

?? **Cloeodes** sp. No. 1

Nymphs which superficially resemble those of *Baetis garcianus*, but with hind wing buds wholly lacking, and distal joint of labial palp lobed, as in figure 16. Probably do not belong in this genus.

Nymph.—Head pale reddish brown; median line of vertex and occiput, and epicranial suture, faintly pale; a dark brown spot on each of first two basal joints of antenna. Maxillary palp two-jointed (fig. 31); labial palp likewise two-jointed, distal joint mitten-shaped, as in figure 26. Thoracic notum light reddish brown, median line paler; indistinct, paler, markings laterally on pronotum, and on mesonotum anterior to wing roots. Pleura and sternum paler than notum; dark areas on pleura above leg bases. Legs yellowish. Femora faintly tinged with smoky, and with a brown spot at apex; claws pectinate. Abdominal tergites quite uniformly light red-brown, somewhat paler next to pleural fold; in some specimens, tergites 9 and 10 are slightly paler. Intersegmental areas yellowish. Posterior margins dark brown; postero-lateral angles shaded with smoky brown, and with a dark dash at base of each gill. Indistinct, paler, markings are visible on some specimens, as follows: anterior portion of median line; spot on anterior margin halfway between median line and pleural fold; round, submedian, spot on each side, at about center of tergite. Two short, dark, transverse, dashes on anterior margin, one on each side of median line. Sternites somewhat paler than tergites; on each, a narrow,

dark, transverse, line on anterior margin, in median area only. A distinct, dark, spot at each spiracle, and a dark line leading forward from this to anterior margin, are faintly seen from dorsal view, but are much more evident on ventral surface. Gills single, obovate, intermediate ones asymmetrical as in *Baetis garcianus*, but slightly longer and less rounded at apex. Tracheation pinnate, very indistinct; only the basal portion of main trunk is clearly evident. Tails three; yellowish, crossed by two prominent black bands, the distal of these being the wider. Middle tail slightly more than half as long as the laterals.

Length: body 4–5 mm.; tails 3 mm.

Specimens of this species were taken during 1935 (J. G. Needham, J. García-Díaz) at Utuado Road (Mch. 13); Río Blanco (Mch. 6); La Joba Creek at Río Blanco (Mch. 8); Cagüitas River (Mch. 4); Carreres River (Mch. 9); small creek near Jayuya Road (Mch. 24); and the Luquillo Mts. (Feb. 18, May 26).

Cornell University, Nov. 30, 1936.

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Explanation of Plates

Plate I

Fig. 1.—*Neohagenulus julio.* Male imago; wings.

Fig. 2.—*Borinquena carmencita.* Female imago; tip of abdomen, showing long ovipositor.

Fig. 3.—*Neohagenulus julio.* Male imago; genitalia.

Fig. 4.—*Borinquena carmencita.* Male imago; wings.

Fig. 5.—*Baetis garcianus.* Male imago; genitalia.

Fig. 6.—*Cloeodes portoricensis.* Male imago; genitalia.

Fig. 7.—*Neohagenulus tinctus.* Female imago; tip of abdomen, ventral aspect, showing egg valve and subanal plate.

Fig. 8.—*Borinquena carmencita.* Male imago; forceps base and portion of basal joint of forceps.

Fig. 9.—*Baetis garcianus.* Male imago; hind wing.

Fig. 10.—*Borinquena carmencita.* Male imago; hind wing.

Fig. 11.—*Neohagenulus julio.* Male imago; hind wing.

Fig. 12.—*Borinquena carmencita.* Male imago; genitalia.

Fig. 13.—*Cloeodes maculipes.* Male imago; genitalia.

Plate II

Fig. 14.—*Neohagenulus julio.* Nymph; tibia of third leg.

Fig. 15.—*Neohagenulus luteolus.* Nymph; tibia of third leg.

Fig. 16.—*Neohagenulus julio.* Nymph; femur of fore leg.

Fig. 17.—*Neohagenulus luteolus.* Nymph; femur of fore leg.

Fig. 18.—*Neohagenulus luteolus.* Nymph ; gill from third abdominal segment.

Fig. 19.—*Borinquena carmencita.* Nymph; gill from third abdominal segment.

Fig. 20.—*Cloeodes maculipes.* Male imago; lateral view of head.

Fig. 21.—*Neohagenulus julio.* Male imago; lateral view of head.

Fig. 22.—*Borinquena carmencita.* Male imago; lateral view of head.

Fig. 23.—*Baetis garcianus.* Nymph; gill from fourth abdominal segment.

Fig. 24.—*Baetis sp. No. 1.* Nymph; gill from fourth abdominal segment.

Fig. 25.—*Baetis sp. No. 1.* Nymph; labial palp.

Fig. 26.—? *Cloeodes sp. No. 1.* Nymph; labial palp.

Fig. 27.—*Cloeodes maculipes.* Nymph; labial palp.

Fig. 28.—*Cloeodes portoricensis.* Nymph; labial palp.

Fig. 29.—*Cloeodes maculipes.* Nymph; maxillary palp.
Fig. 30.—*Cloeodes portoricensis.* Nymph; maxillary palp.
Fig. 31.—? *Cloeodes sp. No. 1.*—Nymph; maxillary palp.

Plate III

Fig. 32.—*Borinquena carmencita.* Nymph; labium.

Fig. 33.—*Borinquena contradicens.* Nymph; detail of canines of mandible.

Fig. 34.—*Borinquena contradicens.* Female subimago; tip of abdomen, lateral view. Ovipositor somewhat flattened out.

Fig. 35.—*Borinquena contradicens.* Nymph; maxilla.

Fig. 36.—*Borinquena contradicens.* Male imago; penes, enlarged.

Fig. 37.—*Borinquena carmencita.* Male imago; tip of abdomen, lateral aspect, showing the very long forceps. One tail omitted.

Fig. 38.—*Borinquena contradicens.* Nymph; hypopharynx.

Fig. 39.—*Borinquena contradicens.* Nymph; gill from third abdominal segment.

Fig. 40.—*Borinquena contradicens.* Nymph; labrum.

Fig. 41.—*Borinquena contradicens.* Male imago; genitalia.

Fig. 42.—*Cloeodes maculipes.* Nymph; gills of second and third abdominal segments; showing abdominal segments three, four, and five.

Fig. 43.—*Cloeodes portoricensis.* Nymph; gills of second, third, and fourth abdominal segments; showing abdominal segments three to seven.

Fig. 44.—*Neohagenulus julio.* Male imago; penes, enlarged, one side distorted, showing what appears to be long, slender, spine on inner margin.

Fig. 45.—*Cloeodes maculipes.* Male imago; third leg. A; same, enlarged.

Fig. 46.—*Neohagenulus luteolus.* Nymph; claw of fore leg.

Fig. 47.—*Neohagenulus luteolus.* Female imago; hind wing.

Fig. 48.—*Neohagenulus luteolus.* Nymph; labium.

Fig. 49.—*Neohagenulus luteolus.* Nymph; mandible.

Fig. 50.—*Borinquena contradicens.* Male imago; hind wing. B; same species, female subimago, showing tip of wing folded over.

PLATE I

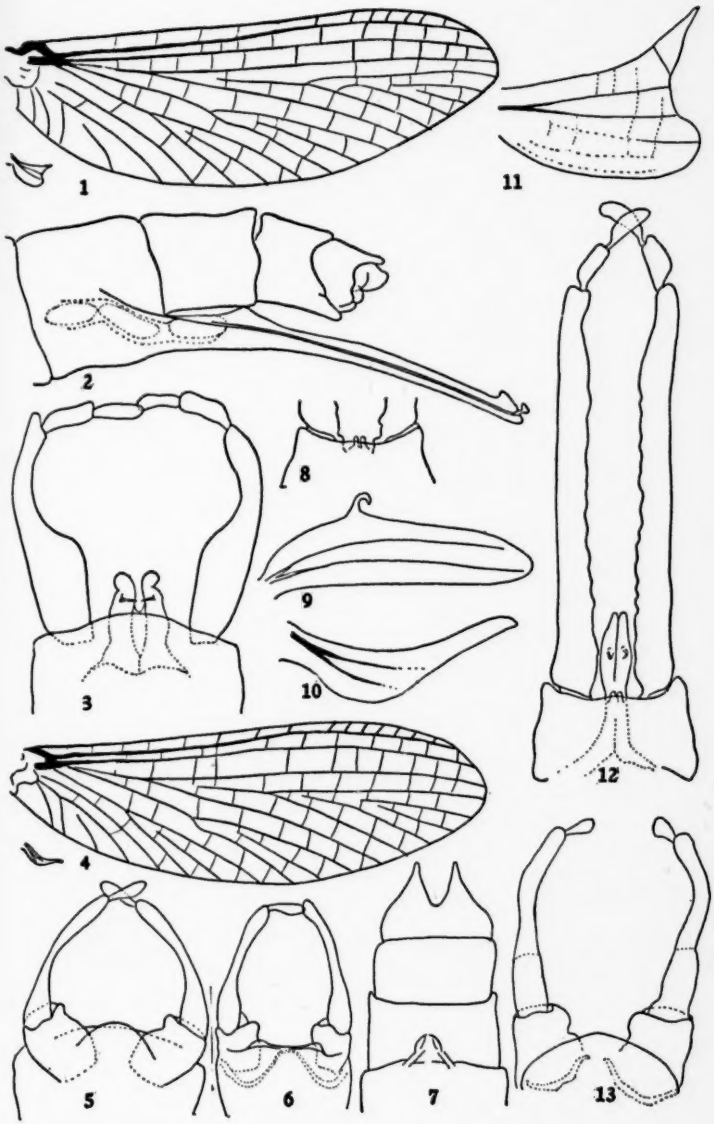


PLATE II

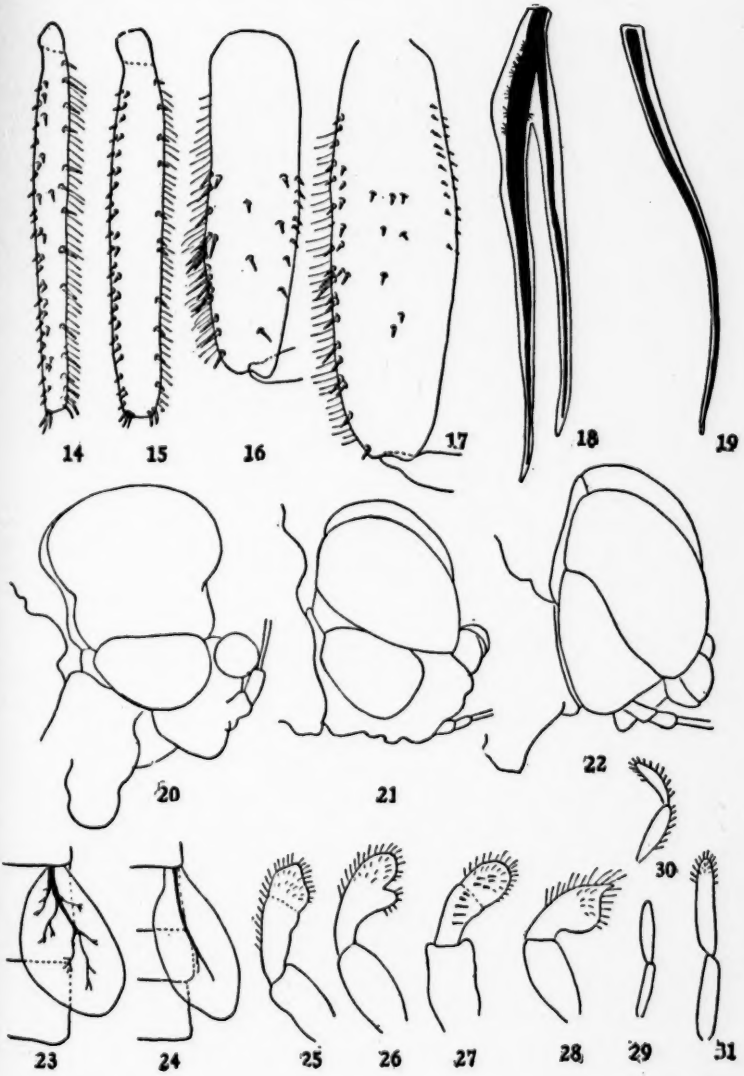
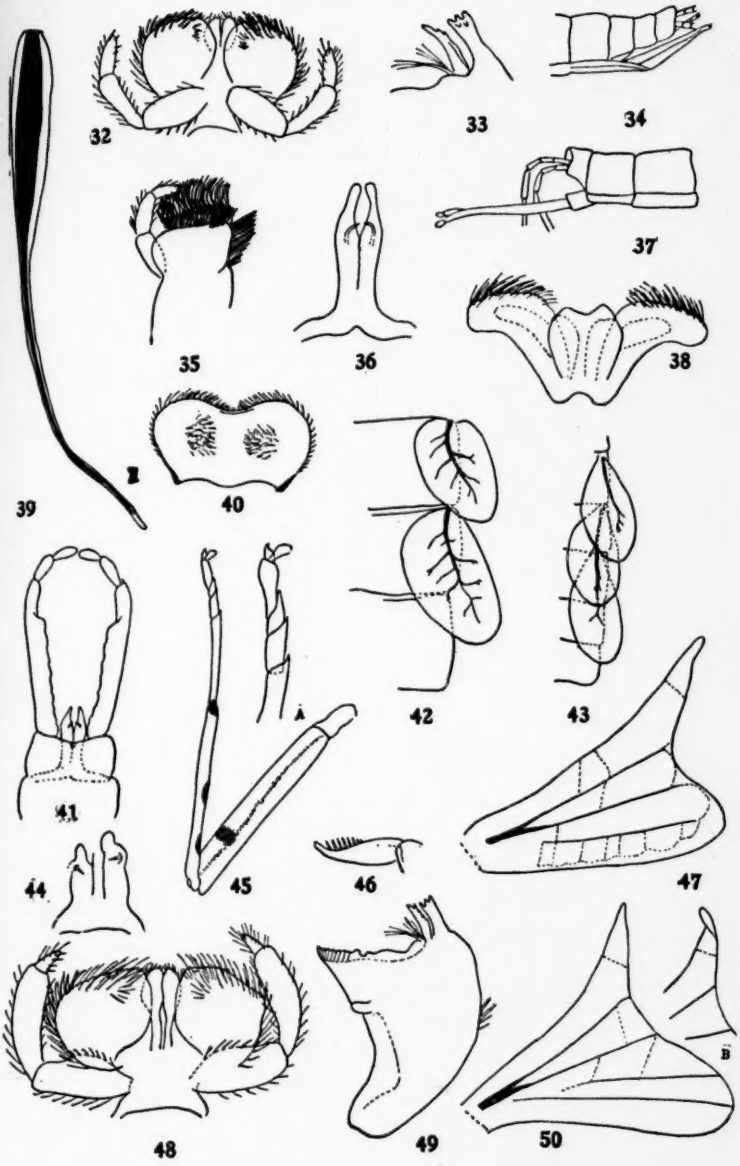


PLATE III



AN ECOLOGICAL SURVEY OF THE FRESH WATER INSECTS OF PUERTO RICO *

1. THE ODONATA: WITH NEW LIFE-HISTORIES

JULIO GARCÍA-DÍAZ,
University of Puerto Rico.

Very little intensive work has been done in the fresh water fauna of the Island. The Fish Commission Expedition to Puerto Rico in 1900 said: ". . . An examination of the literature pertaining to the Natural History of the West Indies showed that comparatively little was known concerning the fishes, and scarcely anything of the other aquatic animals or of its aquatic flora." Although the conditions at present are not so critical in the entomological field because of the work of Howard, Dyar and Knab (1912), Dyar (1928), Curran (1928) (1931), Leng and Mutchler (1914) (1917), Barber (1923) and Needham and Fisher (1936), who included in their publications the aquatic insects belonging to the groups discussed; as well as the articles published by other authors like Tower (1912) (1921), Hoffman (1925), Root (1929), Earle (1930), Wells (1930), Bradt (1932) and others, the aquatic insects of the Island are far from well known. Two other workers, Klots (1932) and Alexander (1933) have contributed greatly to the knowledge of the insect aquatic fauna. Alexander states in his paper that the reduced number of species must be due to lack of collecting rather than to the scarcity of species. His contention has been corroborated by the material he most kindly determined and shown in appendix A. A glance through this, which shows the determinations made up to the present time by the specialists to whom material has been submitted, supports also the statement made before.

In spite of the small size of the Island its fresh waters harbor species of all the phyla which in similar environments occur over the world. Protozoans, coelenterates, platyhelminthes, nemathelminthes, annelids, molluses, arthropods and vertebrates, all of them, in their adult or developmental stages have representatives in the different fresh water habitats of the Island. Among the aquatic insects there are members of all orders having them, with the only possible excep-

* Limnological laboratory of Cornell University.
Department of Biology, University of Puerto Rico, No. 9.

tion of the Plecoptera. Very striking is the apparent absence of these, which must be attributed to their impossibilty, beng poor flyers, to reach the Island. This seems to be the only factor because places where they could live are plenty all over.

The habitats for all these species vary greatly, from the rapid, turbulent flow of the rivers in the higher levels of the Island, through the slow moving courses of the same along the coastal plains to the few small standing lakes, lagoons, pools and marshes.

Puerto Rico has been called the land of the rivers, possibly rightly so, if one considers that on its 3,500 square miles there are about 1,500 streams although not all of them are really rivers. The majority are tributaries to about 80 or 100 larger ones. The high altitude of the mountains, attaining heights of over 4,000 feet, when taken in consideration to the width of the Island which is only about 35 miles, make these rivers exceedingly rapid when cutting their way through the gorges of the central mountains range. The placing of the chain of mountains (Fig. 2), which has been secondarily determined by erosion as shown by Meyerhoff (1933), about two thirds away from the northern coast, has a decisive influence upon the nature of the rivers. Rainfall, due to the placing of the mountains in relation to the prevailing winds during the year, is most common on the north side where it may attain a maximum of 140 inches on Mt. El Yunque. Corresponding areas on the southern slope may get only 100 inches and sometimes go through periods of drouth. Thus the rivers which flow into the north and west have longer courses and are less rapid than those on the southern and eastern side. The longest river of the first group may attain a length of 40 miles while the corresponding one of the southern side would be less than half that length. The northern rivers usually have a permanent flow of water while those on the opposite side may dry up completely during sometime in the year. The beds of these rivers vary greatly. There are some rocky ones with practially no loose stones in them high up in the mountains; others are gravelly with small and medium sized boulders along their middle courses and lastly that portion close to their mouths where sandy and silty bottoms are found. The beds of those on the southern slopes, although similar to the ones last mentioned, are more rocky and the boulders are more common in them.

To the mechanical and climatological factors determining the nature of the rivers has to be added the influence brought about by the altering of natural conditions through human activity. The Island being heavily populated has been completely deprived of most

of its natural forests. So a few hours of rainfall may cause the rivers to swell and small streams of water soon become imposing torrents. But with the same rapidness with which they swell do they return to their normal volumes. This rapid run-off washes into the rivers considerable amounts of silt and mud. Because of this, although at the higher levels the water soon becomes clear and transparent, in the lower places it may remain muddy for days of even weeks, depending on the duration of the rain. This mud has settled and filled the bottoms of some rivers which are no longer navigable to small boats as they used to be. This sudden variation in volume of the rivers is nicely shown in their beds which usually are dual in nature. The one where the river normally and continually runs and a wider one marked by the effects of the rushing waters during the floods. Sometimes during this period water is left along the edges of the rivers in the lower lands and holes close to them, and pools and marshes, some temporary others permanent, are formed. Upon reaching the sea the tide tends to keep them back and part of their course, for some distance up, is rendered more or less brackish.

The plant life occuring in the rivers and along their edges and serving as food for the vegetable feeders varies at different levels. High up in the mountains are found very few plants: only the algae, desmids and diatoms which are capable of clinging to the rocks in the swift running waters; in the slower running ones on wet stones and along the edges, are found the mosses and liverworts together with some ferns and higher aquatic plants. Lower down in the less rapid waters the most common and easily seen aquatic plant is Potamogeton besides the algae and lower forms, and along the edges are most commonly found "Malojillo", *Panicum* sp., *Polygonum* sp., and sedges and rushes; close to their mouths, where there is a very sluggish flow, the "flor de agua" *Castalia ampla* Salisb. makes its way farthest toward the center of the river, while farther back along the edges and marshy places the cat-tails *Typha angustifolia* L. and taller sedges like *Mariscus jamaicensis* (Crants) Britton and other smaller ones are seen together with other aquatic and semi-aquatic plants.

There are no true lakes on the Island. The only one which approaches this type of body of water is the one near Manatí called Tortuguero Lake. It occupies an area of 4 by 1½ kilometers, has no permanent inflow of water and fills up only during the rainy season from the waters of the nearby small hills called "mogotes". It is subject to great variations in its level, although it has never been known to dry up completely. I have seen its west end entirely

dry in August and walked along places where it would have been impossible to do it in March when Doctor Needham and I collected at the extreme west end. The shore line on its southern side had receded no less than 25 feet from the original one where collecting had been done during February and March. Notwithstanding its variations, aquatic insect life is always abundant along the shore. The lake has no natural connection with the sea and although very close to it, its waters are fresh. There is the possible exception of those of its northern shore where collecting of insects forms was remarkably poor compared with the southern shore. Possibly the wind and a certain degree of brackishness were responsible for this. There are two pipes leading from the lake to the sea by means of which it is drained when the water level gets too high. The aquatic plants which occur in it and along its shores and serve as food and shelter to aquatic insects have been discussed by Cook (1928). A sphagnum, *S. cuspidatum* var. *serrulatum* Schlisph, kindly determined by Dr. LeRoy Andrews, was found by Doctor Needham along the southern shore of the lake.

The next larger body of water approaching a lake is Cartagena Lagoon. It is much smaller in size than Tortuguero and as indicated by Danforth (1926) subject to wide variations in its water level. Cook (1928) also mentions this fact and states that in 1926 in a period of about two months the shore line had gone back about ten meters. There are records of it having dried up completely. Like Tortuguero it has not permanent inlet of water, neither an outlet. In cases when heavy rainfall fills it most completely Danforth (1926) says it overflows and the excess reaches the sea through the Boquerón river and its tributaries. The plant life found here is similar to the one of Tortuguero Lake and has been also discussed by Danforth and Cook. A remarkable difference in a species of the open water was that of *Nais* sp. which Danforth states in one instance nearly choked the lagoon. When Doctor Needham and I were there *Nais* was not so common but its place was ocupied by *Ceratophyllum* sp. which was very thick. Cartagena Lagoon like Tortuguero Lake, harbors a numerous fauna of aquatic insects as well as other fresh water forms.

There are a few, other smaller lagoons along the northern coast. Also those like that of Guánica and two smaller ones near Cabo Rojo. Some collecting was done in them but they do not seem to compare in any way to the larger two.

Swamps are most common along the northern shore. The largest one is Caño Tiburones between Arecibo and Barceloneta. Through

its natural outlet by way of Arecibo River; through the canal which has been opened at its east end and leads into the Manatí River, and through the many ditches and canals made trying to drain it as indicated by Cook (1926), a large area has been rendered salty. The waters are not fitted for all fresh aquatic insects and only the hardier ones seem to be found there. Very little or practically no collecting has been done here.

A peculiar and highly specialized fresh water habitat on the Island is represented by the sink holes near Isabela. A dry region, generally speaking, these sink holes which retain the water of the few showers, offer the only place for aquatic animals. Some of them, in August, were nearly dry, others completely choked with the "flor de agua" and "lechuguilla de agua" (*Pistia atratiotes* L.) while others had some water in them. All at the time mentioned, were very muddy and did not look very promising for collecting. Yet, they yielded heavily both in number of species and in individuals. Because of the nature of the surrounding country the water of these sink holes has a high alkalinity and possibly this may have some effect upon their inhabitants.

An additional habitat for the fresh water forms is the one offered by the irrigation systems developed in some parts of the Island. What is the nature of the forms living here I do not know since not much collecting has been done in them. I have collected mayflies, Baetinae, in a small, temporary system near Fajardo. If in such a small one as this mayflies were collected, there is no doubt that the more permanent ones of Isabela and Juana Díaz would certainly yield much more. Their importance in upsetting natural conditions through the agency of fresh water forms living in them has been pointed out by Earle (1925) (1930) who warned of the dangers of the extension of malaria on the Island due to the breeding of mosquitoes in the temporary pools formed in the irrigation ditches. Hoffman also believes they will be means for the distribution and spreading of Schistosomiasis as it may have happened already in Guayama and adjacent places, by offering breeding and living places for *Planorbis* sp., the snail which is the intermediate host of the latter disease.

With such a variety of environment in which to live, fresh water forms and thereby aquatic insects must be numerous. How has it been possible to miss, up to this time, some of them, is more than an usual happening which can be accounted for only by the absence of an intensive collecting. Mayflies, although not so common on the lowlands, are certainly numerous along the creeks in the higher areas

and no citation, but with only one exception, is found in current literature about the group. This is in strong contrast with the findings of Dr. J. R. Traver as shown in Appendix A.

The two hundred vials which contained the material collected by Dr. James G. Needham and myself during the months of February and March, together with those accumulated by me during periods of irregular collecting, when finally sorted turned into two thousand. From their contents have come out a number of additional records as well as additional new genera and species which I hope may be a stimulus to further the interest on the Island's fresh water fauna.

Interesting and important as is the determination of the existing species there still remains a no less during and satisfying phase of the work. Set in a peculiar environment, due to special physiographical and biological conditions together with the fight among themselves for food, shelter and ability to perpetuate their kind by means of reproduction, with the ensuing struggle for existence, each one of these groups has developed special means of meeting conditions for the aforesaid purpose. To study their occurrence, distribution, relationship and some of their adjustments and how they have developed is a most fascinating enterprise. The pages to follow are a most humble start in one of the groups. The discussion is based on part of the material collected by Dr. James G. Needham and myself. He not only determined the species but placed at my disposal the notes and records which he made during his stay on the Island and upon which I have drawn. For his wise counsel and many kindnesses during our long association, I will be always greatly obliged. A similar obligation and appreciation is herein expressed for all the specialists who have determined the material included under their names in Appendix A as well as to those others to whom some material has been submitted and is under way of determination. My thanks also to all others who in any direct or indirect way have helped me during my work. The drawings on plates IV, V and VI were done by Dr. Velma Knox, and the wings on plate VII were photographed by Mr. Archie Hess. To both of them my sincere thanks.

ODONATA

The dragonflies are among the insects most commonly seen in Puerto Rico. How Ledru (1810) failed completely to report in his list these insects is not understood. In any open space, along the many rivers on the Island, along the shores of the lakes, lagoons, or temporary pools fly these conspicuous forms of insect life. There are

some that are not so easily spotted due to their habits of keeping in shady places or else among the plants close to the bodies of water, which are easily missed unless specifically looked for.

The number of species, forty-three, herein discussed is considered small if compared with those of Cuba. Doctor Klots (1931) in her excellent paper on the Odonata of Porto Rico and the Virgin Islands attributes this reduced number to the scarcity of breeding places but "the fact of Cuba's longer association with the continental land mass and of Porto Rico's earlier isolation" should receive further consideration. This earlier isolation preventing the arrival of some forms, together with the subsidences and upliftings of Puerto Rico which brought changes in climate and habitats, these latter ones especially along the coast, may have been factors determining the odonate fauna. Extinction also through the action of the stronger odonates feeding upon the weaker, as well as destruction brought about by other animals, may have been deciding factors. Schmidt (1930) in discussing the amphibians and reptiles mentions some of the preceding factors, and although there is a great difference between these forms of animal life and insects, still there is a possibility of considering them. Taking in consideration the number and nature of the rivers on the Island, as well as lagoons and other swampy places, I think there are enough breeding places for supporting a larger number of species than those at present in existence. Puerto Rico, at least on its northern side, is amply supplied with rivers which do not dry up during the entire year and also there are a few lakes which could be used as breeding places. It is true that lakes are scarce and only one, Tortuguero Lake, has never been known to dry up, but the rivers with their rapid running waters high up in the mountains and their sluggish courses along the coastal plain could afford places to lotic and static species wherein to breed. Wilson (1911) while discussing the Odonata of Jamaica points out the influence of the nature of the rivers of the Island in keeping the majority of the species "confined to the immediate vicinity of the isolated ponds and quiet streams".

There is the possibility of the extinction of some of the species originally occurring on the Island. The case of *Protoneura capillaris* and *Leptobasis vacillans* failing to be collected together with all the other forms reported from the Island tends to show something along this line. This consideration is highly questionable since there is always the possibility of not having hit the places where these forms breed. A specimen of the former was collected in a house, flying to lights, in Hato Rey, near Río Piedras, by the author about

six years ago, but unluckily he failed to state definitely the date when caught and it was impossible to do it years afterward when the specimen was determined. No other specimens have been ever collected. This is also the case with *Leptobasis.*

Taking as a basis all available records, those published as well as those based on the collecting done by Doctor Needham and the author, a seasonal distribution of the Odonata of Puerto Rico has been considered. Fig. I shows this distribution. Taken as a whole there seems to be no seasonal distribution of the Odonata. There are extreme cases which tend to show the contrary, but a more intensive collecting and detailed observations in the biology and ecology of those forms may modify such views. Very little has been done along the ecology of these insects on the Island, most of the information available being only along strictly taxonomic lines. In the impossibility of formulating any reliable general statements the individual species will be discussed later, always condtioned by the need of further observation and more widely spread collecting. The maps, Fig. 3 and 4, showing the collecting places give the impression that the Island as a whole has been fairly covered. But in a majority of those placed no intensive collecting has been carried out and when this is done changes and modifications of present conditions are certain to crop out.

An altitudinal distribution of the forms was also tried as shown in Table II. As in the previous cases and for the same reason it is impossible to make general statements. The different species of *Anisoptera* upon which data are available may be grouped into four main divisions: (1) above 2,000 feet: *Macrothemis celeno* and *Scapanea frontalis.* Nymphs of *Dythemis rufinervis* have been collected also above this level. If a nymph collected in Buena Vista Camp in Maricao Forest Reserve is an *Aeschna,* as it is being assumed, there would have to be added to this group *Aeschna cornigera* which is the species reported from the Island. Adults of the latter have been collected in the next division. (2) Above 1,000 and up to 2,000 feet: *Aeschna cornigera, Anax junius, Dythemis refinervis, Erythrodiplax connata justiniana, Erythrodiplax umbrata, Lepthemis vesiculosa, Orthemis ferruginea, Tramea abdominalis,* and *Pantala flavescens.* (3) Above 500 and up to 1,000 feet: *Erythemis plebeja* and *Tramea binotata.* (4) From sea level up to 500 feet: *Brachymesia herbida, Cannacria furcata, Coryphaeschna adnexa, Erythrodiplax minuscula, Idiataphe cubensis, Miathyria marcella, Micrathyria aequalis, Micrathyria dissocians, Perithemis domitia* and *Tramea onusta.* Here should also be added *Anax amazili* known only from

the Island by its nymph and *Acanthagyna nervosa* of which there are no available records as to adult distribution,[1] but Doctor Klots' (1932) supposition of a nymph would place it in this group. If from group 3 and 4 are removed the two *Trameas* and placed in group 2 where the other occurring on the Island has been found and also *Coryphaeschna adnexa* which because of being a strong fiier could easily go to higher levels, there would be a possibility of reducing all forms to two main divisions: those capable of trespassing the 1,000 feet level and the other below this altitude and possibly restricted to the coastal areas or lower levels of the Island.

In the Zygoptera, Table II, three main groups have been found: (1) Above 2,000 feet, *Telebasis vulnerata* is found. (2) From 1,000 to 2,000 feet with *Telebasis dominicanum* and *Enallagma civile* as adults plus *Enallagma coecum* and *Lestes forficula* as nymphs included. (3) From sea level up to 500 feet comprising *Anomalagrion hastatum*, *Argiallagma minutum*, *Ceratura capreola*, *Enallagma cultellatum*, *Ischnura ramburii*, *Lestes forficula*, *Lestes scalaris*, *Lestes spumarius*, and *Protoneura capillaris*. If from group three, as in Anisoptera, are removed the *Lestes* included, and *Enallagma cultellatum* placed arbitrarily with the other *Enallagmas*, there could be also two main divisions: those not trespassing the 500 feet and the ones going higher than the 1,000 feet level; the geographical regions corresponding to those indicated under Anisoptera.

Because dragonflies are strong fliers the altitudinal distribution of adults has not a great meaning unless it is correlated with the same distribution of their nymphal stages. The incomplete knowledge of distribution on the island of such stages makes impossible, except in individual cases later indicated, such correlation and the preceding discussion will be, no doubt, greatly modified as more data are accumulated.

Little could be said about the horizontal distribution of Odonata, especially along the lower levels, due to the ability of the adults to fly for very long distances. But there seems to be some forms which are strongly localized as shown by the collecting done up to the present time. Here would belong *Ceratura capreola* and *Argiallagma minutum* among the Zygoptera and *Idiataphe cubensis* among the Anisoptera. A decided case of localization was observed in the Guajataca River near Lares about 1,000 feet above sea level. Here were collected nymphs of *Dythemis rufinervis* and *Scapanea frontalis* in large numbers. A distance of two feet determined the species to be obtained. In a small pool, with its bottom covered with fine sand and

[1] See note at end. (page 85.)

silt, were to be collected the nymphs of the first. So numerous were they that they could be seen through the clear water, running in front of the net. Two feet below in the small riffles and clinging to the loose stones and pebbles of the gravelly bottom one could obtain only the nymphs of Scapanea.

It is a very striking fact the absence of the larger forms of Anisoptera like *Anax, Coryphaeschna* and others when compared with the smaller forms of the same suborder normally flying as adults all over the Island. Among the Zygoptera it is also noticed the relative absence of the *Lestes* spp., the largest Zygoptera on the Island, when compared with the rest of the members of this suborder. Wilson (1911) noticed also this fact while collecting in Jamaica. The factor determining this condition is not clearly understood, more so in the case of *Anax junius*. This species has been found in the nymphal stage in pools and in Tortuguero Lake where due to its large size it could have easily lived in competition with smaller forms. Yet the number of adults when compared with the rest of the forms in the mentioned lake was exceedingly low. A similar situation exists with *Coryphaeschna:* lots of nymphs were collected by Doctor Needham and the author in Tortuguero Lake, but not a single adult was seen. It could be thought that the season for transforming had not been reached, but in no case of the many occasions the author has been on the mentioned lake, has he seen the large anisopterans showing up. Possibly the large size of the nymphs make them easy pray to other more aggresive enemies or to some parasites, or either the adults have seludd habits and keep among the plants and trees close to the breeding places.

The geographical distribution of the odonate fauna of the West Indies, and thereby of Puerto Rico, has been discussed by de Selys (1856) who in placing the odonata fauna of Cuba at that time considered it closest to that of Florida and South America. He pointed out the scarcity of the Gomphinae, only represented by *Aphylla caraïba*, as well as the Calopteryginae represented only by another single species *Hetaerina luteola* Rambur (*Hetaerina cruentata* Selys) and the complete absence of the Cordulinae. Kolbe (1888) and Wilson (1911) considered affinities mainly with South American forms and Klots (1932) states " . . . that our characteristic Antillean fauna is most nearly allied to that of Central America, and that it arrived probably at the time of the late Tertiary connection with Central America, when all our present families of Odonata were in existence. . ." In accounting for a few forms found in Jamaica and Haiti and not present on the other islands she admits the

possibility of a ". . . secondary land bridge via the east-west mountain chain from Haiti through Jamaica to Honduras, in addition to the Yucatan–Cuba connection". She further indicates the importance of the flight habits of the dragonflies as well as the presence or absence of bodies of water and the latter in determining the distribution of this form of insect life.

In playing their part in the economy of nature odonates follow all other forms of animal life. Among the most common enemies of odonates are the birds which attack both nymphs and adults. Gundlach (1878) mentions 31 species feeding on insects, but in no case makes specific reference to particular insects and so no mention of the odonates is made. Bowdish (1902) (1903) mentions 30 species attacking insects, but only two of them *Mimus polyglottos orpheus* (Linnaeus), Jamaican Mocking bird, and *Melanerpes portoricensis* (Daudin), Porto Rican Woodpecker, are reported as having eaten adult dragonflies. Wetmore (1916) of 69 species feeding on insects mentions 12, or 17.4 per cent of them preying on odonates whether in adult or nymphal stage, (Table III), *Butorides virescens cubanus* (Oberholser), Cuban Green Heron, and *Marila affinia* (Eyton), Lesser scaup duck, heading the list in percentages. Eighty-four per cent of the stomach food contents of three herons was made up of the ". . . abdomen of adult dragonfly, nymphs and several damsel flies". and 69 per cent of the ducks food was made up of dragonfly nymphs. Danforth (1926) who discusses the stomach food contents of 53 species, (Table III), found 15 of these, or 28.3 per cent had eaten odonates. *Totanus melanoleucus* (Gmelin), Greater yellow legs, and *Falco columbarius columbarius* (Linnaeus), Pigeon Hawk, represent the two worst enemies of dragon and damsel fly nymphs respectively with corresponding percentages of 65.33 and 12 of their food. The Pigeon Hawk, again and *Egretta candidissima candidissima* (Gmelin), Snowy Egret, are the ones with heaviest toll among the adult dragon and damsel flies in the order mentioned with 73 per cent and 15 per cent respectively. Most of the adult odonates, may have been taken while transforming and not able to fly very much, but there is no doubt that some of them are caught while on the wing as has been observed by Danforth in the cases of *Hydrochelidon nigra surinamensis* (Gmelin), Blacktern, and *Tyrannus dominicensis dominicensis* (Gmelin), Gray kingbird, the latter seen catching *Lepthemis vesiculosa* (Fabricius) which is a rather swift dragonfly. Dr. James G. Needham has seen also this last bird catch on the wing *Tramea abdominalis* Rambur which in its flight is still faster than the former dragonfly.

In the nymphal stage dragonflies are picked upon more often than damselflies, a thing which is natural due to the small size of the damsel fly nymphs and also to their habit of clinging to small stems under water. Danforth's work shows that 53.3 per cent of the species of birds feeding on odonates attacked the nymphs of the dragonflies while only 13.3 per cent of them had eaten damselfly nymphs. In the adults the conditions are reversed, 40 per cent of the birds feeding on damselflies while 20 per cent feed on dragonflies. This is a good correlation, the latter being better fliers and standing usually in open spaces where they can see their enemies while the former are poor fliers, if compared with their relatives, and keep more often among the grasses close to the water on which they rest for longer periods and can be caught thus more easily.

Lizards have been reported to prey also on odonates, but Wolcott (1924) found only one case in 50 individuals of *Anolis pulchellus* Dumeril and Bibron, where a damsel fly, *Enallagma* sp., had been eaten. Dexter (1932) found that the nymphs of odonates constituted 0.8 per cent by bulk of the food of 301 specimens of *Bufo marinus* L. I have seen the latter sitting on the leaves of water plants from which I have collected transforming damselflies in Cartagena lagoon and certainly some of these have been eaten. Fishes are by far the worst enemies of the nymphs and in a few cases of adults. I have not found any data regarding Puerto Rican fishes.

But to all this fight with other species has to be added the struggle among the nymphs and adults of the odonates themselves. I have seen the big *Anax* feed upon the rapid *Lepthemis* and this in turn on *Erythrodiplax umbrata*, and Doctor Needham observed repeatedly cases of cannibalism among *Ischnura ramburii*. The fight easily seen in the air is no less intense and fierce in the water where the young nymphs fall easy prey to the larger ones.

The odonates in their adult stage are beneficial because of their predatory habits and destruction of many harmful insects like the mosquitoes. Nymphs may be counted also in the same category, but this is lessened by the fact that the nymphs may destroy young fishes. The adults feed upon mostly any kind of insect that they can get hold of. In Tortuguero Lagoon the numerous *Lepthemis* flitting in the air at the time of observation, February and March. were attacking the small white swamp moths *Nymphula fluctuosalis* Zeller which were then very abundant. These moths flew very low over the water surface, among the emergent aquatics, and so were in part protected from *Lepthemis*, but did not have such protection when attacked by *Lestes* sp. and other damselflies, which were feeding upon

them eagerly, because these latter ones fly also close to the surface of the water. In the Yúnez River in the gorge above the bridge on Km. 19.6, I have seen the big *Anax* together with some swallows, early in the morning, flying up and down the river and feeding on the adult mayflies dancing in the air about 30 to 40 feet above.

After the general remarks before made the following discussion will include observations applying to the individual cases and which could not be included before. The species will be placed for convenience in alphabetical order.

Aeschnidae

This family is represented by the subfamily Aeschninae only. The six species reported from the Island are by no means common either in the adult or nymphal stage. The most common one seen in flight is *Anax junius* and only a few recent records of *Aeschna cornigera* (A.M.N.H.) and *Coryphaeschna adnexa* (Needham and García-Díaz) are to be found. I saw once, at dusk, flying above the level of the electric light post about 30 feet high in Stop 38½ Hato Rey, near Río Piedras, an adult Gynacantha.[1] I have the impression of having collected also a teneral specimen of the latter under the wireless towers at Cayey, but the misplacing of the specimen makes it impossible to state it as a fact. The nymphs of *Anax* are by far the commonest and they are easily told from those of *Coryphaeschna*, when alive, because the latter have whitish eyes while the former do not.

Acanthagyna nervosa Rambur

No adults have been collected.[1] Gundlach (1888), collected them in Cuba on December 15 near Cárdenas and in the Zapata swamp; Kohl (1916) records them from the Isle of Pines, September 11, 1912. The nymph, if Klots' (1932) supposition is right, was caught July 31st, 1926, on the university campus in a ditch with temporary water where the sewage overflow of a building was discharged. The water was ill-smelling due to a dead cat in the water a short distance from where the nymph was collected. No other odonate nymphs were found here and only some tadpoles with it. From this it appears that the nymph does not require clear running or clean water. The tadpoles probably served as food.

Aeschna cornigera (Brauer)

The adult upon which this record rests was caught in Adjuntas, June 8–13 (A.M.N.H.). No other adults have been seen or collected.

[1] See note at end. (page 85.)

A nymph collected by Doctor Needham, March 23, 1936, in a creek ic front of Camp Buena Vista in the Maricao Forests, over 2,350 feet above sea level, seems to be an Aeschna, but is too young to make an accurate determination.

Anax amazili (Burmeister)

(Pl. VI, Fig. 8)

No adults have been collected in Puerto Rico. The record rests on two nymphs collected by me in Hato Rey, Stop 30, near Río Piedras, September 15, 1926, and determined as such by Byers (1927). The nymphs were full grown. The place where they were collected was a rather shallow temporary pool, not over three feet deep at its most, whose water remained usually very clear during the rainy season. Many other odonates as nymphs and adults were collected and seen in this pool, but only *Anax junius* belonging to the Aeschninae was caught here on different occasions on the wing. The pool dried up completely during the year so the life cycle must take place in a year or less. This is possible if we take into consideration Calvert's (1934) paper, who although he thinks that in the greater part of North America two successive generations of *A. junius* do not occur, admits "that under continued high temperature of both water and air two generations per year may be possible". The last two mentioned climatic conditions are easily met on the Island. No more nymphs have been collected. The place of original collection is no longer in existence since the hollow was filled up.

Hagen (1867), calls this species from Cuba "scarce". Calvert (1899) has a record of a female from Tepic, October 1894, 1036 meters altitude, and from Cuba Gundlach (1888) gives records November 15, 1888 and adds "un ejemplar fué cogido en Octubre 1871 en la Habana". This shows the species occurs at widely different altitudes and its indicated infrequent occurrence in Cuba possibly accounts for absence of adults in Puerto Rican collections.

Anax junius (Drury)

Although not very often seen, the records show it is to be found throughout the entire year and from sea level 2,000 feet up. Most easily caught when copulating because when doing so the pair usually rests along the shore of the pond. Needham (1901) has discussed the habits of the nymphs which are "notoriously cannibalistic" a fact possibly acounting for the very few reaching adult stage. La Muda, Feb. 21; Almirante Road Km. 6.7, March 9; Lares, March 22;

Cabo Rojo, Feb. 23; Needham and García-Díaz. Nymphs; Lake Tortuguero, Feb. 19; March 20; Almirante Road, Km. 6.7 March 18, Needham and García-Díaz; Cartagena Lagoon, Oct. 31; Isabela, May 12, García-Díaz.

Coryphaeschna adnexa (Hagen)

(Pl. V, Fig. 4; Pl. VI, Fig. 7)

In only two places were adults of this species seen. I have records from Cuba in May, June and November which tends to show that adults occur throughout the whole year if these records are added to the ones indicated here.

Large numbers of the nymphs of this genus were collected on the west end of Lake Tortuguero among *Polygonum* plants in standing water about 2½ feet deep. The nymphs of *Anax* were equally numerous. The white eyes of *Coryphaeschna* distinguish them at once.

Florida Road, Km. 4.6, Feb. 28; La Muda, Feb. 21; Needham and García-Díaz. Nymphs: Tortuguero Lake, March 20; Needham and García-Díaz; Isabela, May 12; Cartagena Lagoon; Oct. 31; García-Díaz.

Gynacantha trifida (Rambur)

Not a single record has been added to those of Stahl, Kolbe and Gundlach.[1] A nymph considered by Klots as Acanthagyna has been reported from the Island. I think I have seen and collected this species as stated before. Their habit of flying at dusk is possibly responsible for their absence in collections and Gundlach's mention of their occurrence in the woods is another possibility. It has been caught in Cuba during August and September, occurring in large flocks along the coast and seen migrating from north to south in December.

LIBELLULIDAE

These are the dragonflies most often seen and collected all over the Island. Some of the species ar remarkable for their absence in collections. Among these are *Micrathyria didyma didyma* and *Micrathyria hageni*, specimens of which have not been collected after Gundlach's and Kolbe's records. Two more genera have recently been added to the Puerto Ricant list, *Idiataphe* (= *Ephidatia*) *cubensis* and *Brachymesia furcata*. *Tramea onusta* and *Micrathyria*

[1] See note at end. (page 85.)

aequalis are also new records for the Island. Only where field notes are at hand or additional records to those of Klots (1932) will be discussed below.

Bachymesia furcata (Hagen)

(Pl. VI, Figs. 1, 3, 5)

One of the new records. A single adult male caught in flight in Coamo Springs near the reservoir April 5, 1930, Needham and García-Díaz. No more adult specimens have been collected on the Island, but no collecting has been done in the place of collection since the data before mentioned.

Cannacria herbida (Gundlach)

(Pl. VI, Figs 2, 4, 6; Pl. VI, Fig. 1)

This species seems to be restricted to the costal plain where adults are quite common throughout the year. The adults fly close to the water and to the edge of the river, pond or lake. Usually they select a stick over the surface of the water where they perch persistently and to which they return after repeated disturbance. A female was seen ovipositing in the Bayamón River close to the sea where the water becomes more or less brackish when the nearby sea sweeps in. While ovipositing, unattended by male, she descended swiftly, at long intervals, to the water surface dipping the tip of her abdomen. This procedure certianly made eggs less liable to the fish havoc. No nymphs were discovered at this time. On August 10th the nymphs assumed to be this species by comparison with those of *Cannacria gravida* as discussed by Needham and Fisher (1936) and with Doctor Geijskes' description (1934) were exceedingly common along the Cartagena Lagoon shore.

Tortuguero, Feb. 10, Needham and García-Díaz; Tortuguero, Feb. 15; Río Piedras, Feb. 12; Palo Seco, Mar. 21, Needham and García-Díaz; Río Piedras, Flying to lights at home, one female, May 19; Lago Las Torres, June 21; Cartagena Lagoon, August 10, October 31; Yauco, November 11; Fajardo, Las Cabezas, December 19, García-Díaz. Nymphs: Cartagena Lagoon, August 10, García-Díaz.

Dythemis rufinervis (Burmeister)

This is a species which could be placed with the lotic ones, but is capable of living under completely static environment since it is found high up in the mountain rivers, 2,000 feet, and also in Tortuguero Lake at sea level. The adults are twig perchers. Once

they select a place to stand they come back to it repeatedly when disturbed and even after being hit by the net. The males fly close to the water edge over the stream. They are alert, fast flyers and difficult to get when in flight. The nymphs were collected in large numbers in the Guajataca River, in running water, but in a shallow pool with sandy bottom upon which the nymphs rested. They were not easily seen when at rest, matching with the surroundings, but once moving one could easily see them as they moved on the sand or swam through the water in front of the sieve net. They are capable of standing dryness since some placed in a pail in the late afternoon got out of it and were found next morning in the car or crawling over the sidewalk close to which the car had been left.

Tortuguero Lake, Feb. 10, Needham; La Muda, Feb. 21; Cartagena Lagoon, Feb. 23; Tortuguero Lake, Feb. 15; Florida Road Km. 19.3; Yúnez River, Feb. 28; Río Blanco, Power plant, March 8; Almirante Road, Km. 6.7, March 3; Arecibo, Tanamá River, March 13; Lares, Guajataca River, March 23; Cabo Rojo, Feb. 24, Needham and García-Díaz; Ponce, Río Bucaná, June 21, Coamo, Río Puyón, June 20, García-Díaz. Nymphs: Lares, Guajataca River, March 23; Caguas, March 4; Florida, Yúnez River, Feb. 28; Río Piedras, March 18, Needham and García-Díaz; Florida, Yúnez River, Aug. 14, García-Díaz.

Erythemis plebeja (Burmeister)

One of the most difficult dragonflies to obtain because of its alertness and swift flight and also because it usually chooses open spaces for perching where it is difficult to catch. Cabo Rojo, Feb. 23; Florida, Yúnez River, Feb. 28; Lake Tortuguero, March 20, Needham and García-Díaz; Lago Las Torres, June 21; Cartagena Lagoon, October 31, García-Díaz.

Erythrodiplax connata justiniana Selys

I have found them most abundant in swampy places usually with a lot of vegetation but they occur also along the rivers. They are fast fliers and their direction in flight is erratic. They fly low and seldom stand on the higher plants, preferring the lower ones, usually selecting new perching places every time. Once having located a place where they occur, one is sure to get a good series since they keep close to the place even if many times disturbed. On March 13, 1935, on Almirante Road and in a swamp about one hundred yards west from the road sign Km. 6.7, I collected a good series of this

species many of which had recently emerged. I failed to obtain nymphs since I did not search for them. Two years before, June 27, 1933, I got also a very good series on this locality by the road side. Doctor Needham has a nymph caught in Florida Road Km. 4.6, which he thinks is this species. The adults, though sometimes localized, have been found widely spread over the Island reaching altitudes of 2,000 feet. They like *E. umbrata* do not prefer the open spaces, but the grasses and bushes back of the open waters.

Yúnez River, on the Florida Road Km. 19.3, Feb. 28; Almirante Road Km. 6.7, March 9, 13; Lake Tortuguero March 19–20, Needham and García–Díaz; Almirante Road, Km. 6.7, June 27; Coamo, Río Puyón, June 20, Lago Las Torres, June 21, García-Díaz.

Erythrodiplax minuscula (Rambur)

Judging from collecting done at different times on different places over the Island, this species, like E. *berenice naeva,* is not common. Cartagena Lagoon, October 31, García-Díaz.

Erythrodiplax umbrata (Linnaeus)

Usually the most comon species of dragonfly on the Island. It prefers, as said before, places back of the open water among the weeds or bushes. Not very hard to catch. When flying over the water they keep close to the surface. Copulate most of the time without coming to rest in a very short time and the female begins ovipositing at once, dipping the tip of the abdomen at different places in a small area and then moving to some other place. A striking fact is that although adults are common, the nymphs are not so commonly and easily collected. Possibly the nymphs have habits similar to those of *Idiataphe.*

Idiataphe (= *Ephidatia*) *cubensis* (Hagen)

(Pl. VII, Fig. 3)

Cowley, (1934) finding *Ephidatia* preoccupied has proposed *Idiataphe* for this genus. Dr. James G. Needham found this species for the first time February 10, in Tortuguero Lake where he reared it and has published the description of the nymph. Needham and Fisher (1936). Puerto Rico is the second place in the West Indies where this species has been found. A curious happening is that in Tortuguero Lake, on two different instances—March and August,—the cast skins were numerous, clinging to the stems of sedges and

grasses as well as on the leaves of the same, but the adults were exceedingly scarce to the extent that only two or three were obtained. Do adults keep in secluded places or are they destroyed by some enemies? If the adults are peculiar about their habits no less are the nymphs. For nearly a whole forenoon were nymphs searched for with the sieve and apron nets along the shore of the lake among weeds and water plants with no success. Doctor Needham's suggestion of the possiilbity of hiding among the roots made possible collecting a few living ones. Upon pulling some sedges growing in the water or close to the water edge, they were found living there. Among the roots of some stumps of *Chrysobalanus Icaco* L. in the water along the shore, they were found also. Finding them is a real job and only five nymphs were obtained. Although this species seems to be strongly localized as shown by the record of having been found only in Tortuguero Lake, not too much stress can be placed upon this fact when the habits of nymphs and adults are taken into consideration.

Lake Tortuguero, Feb. 10, Needham; Lake Tortuguero, March 20, Needham and García-Díaz. Nymphs: Lake Tortuguero, Feb. 10, Needham; Lake Tortuguero, Feb. 14, Needham and García-Díaz.

Lepthemis vesiculosa (Fabricius)

One of the most common, if not the comonest, species on the Island. Adults fly tirelessly along the open waters, keeping most of the time close to the shore. They may be ecxeedingly common and yet few cast skins may be found. When copulating they come to rest, those that I have seen, and are then easily caught as in *Anax*. Though I have seen large numbers of them, I have not noticed many of them copulating. The female when ovipositing keeps close to the water and dips her abdomen in the water in limited areas and then moves on. When the tip of the abdomen of an ovispositing female is placed in a vial, the eggs are seen to come out singly, but rapidly, in a stringlike fashion. They stick easily to the bottom or sides of the vial, are whitish-yellow in color, but on standing turn brown. The nymphs live in pools and standing waters, but also in running water since in 1930 Doctor Needham collected numerous nymphs among algae mats growing in the shallow Coamo River back of Coamo Spring hotel. The highest altitude record is 1,800 feet. On Fig. 1 there are some months in which *Lepthemis* is not recorded. This is because there are no actual records, but there is no doubt that this species occurs throughout the entire year.

Macrothemis celeno (Selys)

A widely spread species over the Island. Primarily a lotic one, ranging from sea level to above 2,000 feet. The adults fly along the rivers and usually come to rest on the gravel or stones along the edges. They are very difficult to catch because of their swift flight. When standing on the stones or gravel one has to strike from above, since they have the habit of shooting straight up from their resting place if disturbed. A female seen ovipositing unattended by the male, flew eight to twelve inches above a sandy riffle and made lightning-quick dashes to the water's surface and back again to the same level, hitting the water lightly with the tip of the abdomen each time, this descent and return made so quickly that the eyes could hardly follow. Although present in lower levels, it is most common and easily seen along the water courses in the high levels. The nymphs in the rivers are found among the overhanging roots and stems of plants growing close to the edges.

La Muda, Feb. 21; Florida, Yúnez River, Feb. 28; Río Blanco, on Hicaco River dam above the power plant, March 8; Lares, Guajataca River, March 22; Arecibo, March 13, Needham and García-Díaz, La Catalina, Luquillo Mts., JulJy 2; Ponce, Río Bucaná, June 21; Coamo, Río Puyón, June 21; Cartagena Lagoon, October 31; García-Díaz. Nymphs: La Muda, Feb. 9, Florida, Yúnez River, February 28, Needham and García-Díaz.

Miathyria marcella (Selys)

Apparently restricted to the costal plain where it has been only collected up to the present time.

Cartagena Lagoon, Feb. 23, Needham and García-Díaz; Cartagena Lagoon, October 31, García-Díaz. Nymph: Río Piedras, Forestry Department pool, Feb. 7, Needham.

Micrathyria aequalis Hagen

Collected only north of Cabo Rojo along an irrigation ditch. Not reported before from the Island. Very similar to *M. dissocians* but easily distinguished because of its smaller size and the smaller white spots on segment 7. Cabo Rojo, Feb. 24, Needham and García-Díaz.

Micrathyria dissocians Calvert

The most common species of the genus occurring on the Island in sharp contrast with the marked absence of *M. didyma didyma* and

M. hageni which rest yet upon Gundlach's and Kolbe's records. Apparently confined to the costal plain.

Isabela, March 25, Needham; Cabo Rojo, Feb. 24; Florida, Yúnez River, Feb. 28; Almirante Road Km. 6.7, near Vega Baja, March 9, Arecibo, March 13, Needham and García-Díaz; Almirante Road, Km. 6.7 near Vega Baja, June 27, García-Díaz.

Orthemis ferruginea (Fabricius)

The collecting records thus far are from eastern two-thirds of the Island, but it is certainly present all over. It has been caught from sea level up to the 2,000 feet line. There is no doubt that it will be found above this since this species is capable of wide vertical distribution. A species rather difficult to catch because of its swift flight and perching on twigs in open spaces. Some adults are remarkably red. I have seen a female ovipositing on the tiles of the vestibule of a building in the University and when disturbed insisted upon coming back and doing it again. An adult was caught also April 12, flying to the lights at my home. The nymphs of two reared adults when compared with Klots' (1932) supposition for *Brachymesia gravida* confirmed Doctor Needham's (1936) belief that such supposed nymph is but an *Orthemis*.

Florida, Yúnez River, Feb. 28; Río Blanco, by power house, March 8; Almirante Road Km. 6.7 March 9; Lake Tortuguero, March 20, 21; Arecibo River, March 13, Needham and García-Díaz. Río Piedras, an adult flying to home lights, April 12; La Catalina, Luquillo Mts., July 22; Ceiba, Ensenada Honda, July 24; Río Piedras, June 22; Fajardo, Las Cabezas, December 19; Yauco, November 1; Ponce, Río Bucaná, June 21, García-Díaz. Nymphs: Isabela, March 25, Needham.

Pantala flavescens (Fabricius)

Not so common as the other species. Prefers sunny open spaces where it flies tirelessly keeping usually almost the same level, and about five feet from the ground, while getting its food. Usually there are a few together when doing so.

Lake Tortuguero, Feb. 10, Needham; Almirante Road, near Vega Baja, Km. 6.7, March 9, Needham and García Díaz; Fajardo, Quebrada Vuelta, July 24; Yauco, Dec. 1, García-Díaz.

Perithemis domitia (Drury)

The adults are not commonly seen, recorded only from three places on the Island, probably due to their sensitiveness, as mentioned by

Needham and Haywood (1929) to bright shiny or cloudy damp days. I collected a good series of nymphs in a sink hole pool near Isabela, Road No. 2 Km. 103 on May 12. The pool was extremely muddy, heavily loaded with organic matter made up mainly of leaves which had fallen from the trees which surrounded and partially covered the pool. The water fleas and small ostracods were so common that they formed brown patches on the surface and around any stumps above the surface of the water. The nymphs were found along the edges of the pool. Some of them were taken to the laboratory and reared, yielding seven females and three males. The former agree with Dr. Ris (1930) remarks about specimens from Cuba as quoted by Klots (1932). Five of the females show also a brown spot on the anterior wing occupying the first cell of the bridge and part of the cells under this as well as the first cell between M_1 and M_2 sometimes extnding to the other cells above and below this latter ones. On the posterior wing a similar spot past and close to the oblique vein filling part of the area of the cell as well as some of the cells above and below. In two females the spots did not show clearly, but the faintly colored areas could be partially made out. Perhaps the specimens were killed before coloring up completely. The large number of females to males in the lot reared, though it may have no meaning at all, is in strong contrast with their absence in collected specimens. A female seen ovipositing, unattended, in the above-mentioned pool flew close to a piece of wood emerging above the surface of the water and while in flight rapidly and repeatedly touched the wood close to the surface of the water; she did this for a number of times, quit, and began doing it again, repeating the process on different occasions.

Cabo Rojo, February 24, Needham and García-Díaz; Isabela, May 12, García-Díaz, Nymph: Isabela, May 12, García-Díaz.

Scapanea frontalis (Burmeister)

This is mainly a lotic species on the Island and restricted principally to the higher levels, although there are records from Mayagüez and Wilson (1911) found it also in Jamaica "along the dead water at sea level". But the nymphs in Puerto Rico have been collected, up to the present, only above the 500 feet level, becoming commoner higher up. The living adult males make themselves conspicuous while in flight by the white spot near the tip of the abdomen segments 7, 8, and 9, and which does not show in many preserved specimens. The females do not show this spot. Both are strong

fliers flitting close to the water up and down the course of the stream, loitering over pools. They are stremely shy, though approachable, but of one is missed by the net usually all go away. Most of them are caught on the wing. They copulate without coming to rest. Their nymphs are capable of standing dryness to a large degree since they crawled out of a bucket of water during the night, and like those of Dythemis mentioned before, were found the following day on the floor of the car and on the sidewalk. They prefer rapid running water, clinging to the stones—some of them to the under surface.

Luquillo Mountains, February 18; Río Blanco, above Hicaco River dam, March 8; Lares, March 22, Needham and García-Díaz. Nymphs: Florida, Yúnez River, Feb. 28; Arecibo River, near Utuado, March 13; Lares, March 13; Needham and García-Díaz.

Tramea abdominalis (Rambur)

The most common of the Trameas on the Island. Besides flying alone I have seen them flocking together in large numbers while feeding on the Chironomids which keep in cluster from 12 to 15 or 20 feet above the ground. The female may oviposit unattended or with the male. When the latter happens the male releases the female from one to two inches above the surface of the water, when she descends to oviposit hovering meanwhile above and on her coming up the male seizes her again; both fly for a short time and repeat the action described. If the female is missed by the male she continues to oviposit unattended, sometimes the male trying to get hold of her repeatedly. The eggs, yellowish in color, descend slowly in a cluster of 7–10 eggs to the bottom. The keeping of the eggs together in such a fashion without scattering, renders them no doubt subject to the attacks of fishes and other enemies and here is a possible explanation of the comparative scarcity of nymphs of this genus when compared with the number collected of nymphs of other genera.

Río Piedras, Feb. 7, 9; Tortuguero Lake, Feb. 10; Isabela, March 25; Needham; Tortuguero Lake, Feb. 15; Cartagena Lagoon, Feb. 23; Cabo Rojo, Feb. 24; Florida, Yúnez River, Feb. 28; Río Blanco, near power house, March 8; Almirante Road Km. 6.7; March 9; Arecibo, March 13, Tortuguero Lake, March 20, 21, Needham and García-Díaz; Almirante Road, Km. 6.7, June 27; Cartagena Lagoon, Oct. 31; Lares, Oct. 30; Peñuelas, March 24; Lago Las Torres, June 21, García-Díaz. Nymphs: Cartagena Lagoon, Feb. 23, (reared), Neeham and García-Díaz.

Tramea binotata (Rambur)

The least common species of *Tramea* found on the Island if compared with the other two. The nymph is unknown. Florida, Yúnez River, Feb. 28; Almirante Road, Km. 6.7 near Vega Baja, March 9; Arecibo, March 13; Tortuguero Lake, March 19, 20, Needham and García-Díaz.

Tramea onusta (Hagen)

A species not reported from the Island although from the West Indies. I have collected them flying together and among the flocks of *T. abdominalis*. Not captured at higher levels but undoubtedly there.

Cartagena Lagoon, Feb. 23; Arecibo River, March 13; Tortuguero Lake, March 20, 21, Needham and García-Díaz; Ceiba, July 24; Fajardo, Las Cabezas, December 19; Yauco, Nov. 1, García-Díaz.

ZYGOPTERA

An additional genus, *Argiallagma* has to be added to those already listed from the Island and also a species, *Enallagma cultellatum*. Small as are some of them an with peculiar habits of life, as will be indicated presently under each species, a few of these odonates are liable to be overlooked. The status of their nymphal stages remains practically the same as stated by Klots (1932) with the only exceptions of *Enallagma coecum* and *E. cultellatum*, both of which have been reared. To these two should be added a supposition believed to be the nymph of *Argiallagma*. These three nymphs with others of the Anisoptera are discussed further on. It is a striking fact that the nymphs of these odonates, with the exception of those of *Ischnura* and *Enallagma coecum*, are very uncommon although the adults occur in the place where collecting is done. A single family *Coenagrionidae* with two subfamilies *Lestinae* and *Coenagrioninae* have been thus far reported.

Anomalagrion hastatum (Say)

The most inconspicuous of all the zygopterans on the Island and easily overlooked because, although the male has a yellow color, this blends with the dry leaves of the plants in the nearly dry places back of the open waters where they occur. They keep among the plant and weeds and the females, mostly dull colored, are also not easily seen. It seems to be restricted to the lower levels reaching the 500 feet line where it has been collected, though future collecting may alter this view.

Río Piedras, Forestry Department pool, Feb. 8, 9; Tortuguero Lake, Feb. 10, 15, Needham; Guánica Lagoon, Feb. 24; Río Piedras River back of Experimental Station, Feb. 12; Florida, Yúñez River, Feb. 28; Almirante Road, Km. 6.7; near Vega Baja, March 9; Tortuguero Lake, March 19, 20, Needham and García-Díaz; Almirante Road, Km. 6.7, June 27, García-Díaz.

Argiallagma minutum (Selys)

(Pl. IV; Pl. V, Figs. 1, 3; Pl. VII, Fig. 2)

Doctor Needham collected this species for the first time on the Island in Tortuguero Lake, Feb. 10, and later at Almirante Road, Km. 6.7, March 9. Regarding the collecting at this last place he says: ". . . the *Argiallagmas* were captured among the weeds, none over the pond, but in plashy places where they could flit through the small intervening openings from stem to stem. I broke paths through the weeds so as to get about more easily, and then traversed these, scanning the bordering stems for the delicate little damselflies. They did not seem to be common but by diligence got a good lot. Only rarely was any other species found near them; *Anomalagrion hastatum* betimes and very rarely an *Ischnura ramburii;* this latter lives more openly."

So far this species has been collected from only two places and no comment can be made as to its distribution considering the above notes, but it seems to be a localized form. In August I went to Almirante Road, where Doctor Needham had collected adults, to obtain some nymphs, but was unable to find them. Although I searched most carefully, I saw but one adult specimen which I missed when I tried to capture it. I collected though some in Tortuguero Lake.

Tortuguero Lake, Feb. 15, Needham; Almirante Road, Km. 6.7; near Vega Baja, March 9 in copula; Tortuguero Lake, March 20, (in copula), Needham and García-Díaz; Tortuguero Lake, August 16, (in copula), García-Díaz. Nymph: (Supposition) Almirante Road, Km. 6.7, March 9, Needham and García-Díaz.

Ceratura capreola (Hagen)

(Pl. V, Figs. 2, 5)

Another species which tends to be a localized one, keeps among the plants and weeds not flying in the open. Nothing is known about its habits and the nymph is unknown, although Klots (1932) published a supposition and another is also discussed in this paper.

Tortuguero Lake, Feb. 15, Needham; Tortuguero Lake, March 20, Needham and García-Díaz; Florida, in swampy hollow close to River, Aug. 15, García-Díaz.

Enallagma civile (Hagen)

These dainty blue damselflies are found most often in pools and standing water; they may be found also along running water. In flight they keep close to the surface of the pool and do not fly for very long periods, pausing repeatedly on anything above the water or among the plants along the edge. They have been collected from sea level to 2,000 feet. Although adults are common the nymphs are apparently scarce for reasons given in the discussion of the nymphs farther on.

Río Piedras, Forestry Department pool, Feb. 8; Río Piedras, River back of the Experimental Station, Feb. 12; Isabela, March 25, Needham; Cartagena Lagoon, Feb. 23; Florida Road, Km. 4.7, Feb. 28; Almirante Road, Km. 6.7, March 9; Tortuguero Lake, March 20, Needham and García-Díaz; San Germán, April 28; Almirante Road, June 27; Cartagena Lagoon, August 9, 10, November 31, García-Díaz.

Enallagma coecum (Hagen)

This species is primarily lotic, preferring running water but it may be found also along standing waters. Widely distributed over the Island. Its nymph has been collected above 1,000 feet level and the adults above the 2,000 feet line. The former have the habit of hiding among the roots of sedges growing close to the water near the edges and are found also among overhanging roots of other plants. In a random collecting in the creek at Florida Road, Km. 4.7, the nymphs of this species outnumbered those of Ischnura in a ratio of ten to one. No other species of Zygoptera were found with them.

La Muda, Feb. 9; Río Piedras, River back of the Experimental Station, Feb. 12; Florida, Yúnez River, Feb. 28; Florida Road, Km. 4.7, Feb. 28; Caguas, Cagüitas River, March 4, Río Blanco, above Río Hicaco dam, March 8; Almirante Road Km. 6.7, March 9; Tortuguero Lake, March 20; Adjuntas, March 23; Arecibo, Tanamá River, March 13; Needham and García-Díaz; Cayey Wireless Station, May 6; Florida, Yúnez River, August 15; La Catalina, Luquillo Mountains, July 22; San Germán, River near the town, April 28; Ponce, Río Bucaná, June 21; Coamo, River Puyón, June 21, García-Díaz. Nymphs: Florida, Yúnez River, Feb. 28; Florida Road, Km. 4.7, Feb. 28; Caguas, Cagüitas River, March 4; Río

Blanco, above Hicaco River dam, March 7; Almirante Road, Km. 6.7, March 9; Arecibo–Utuado Road, Kms. 56 and 60 near Utuado, March 13; Río Piedras, March 18; Lares, Guajataca River, March 22; Adjuntas, March 23, Needham and García-Díaz; Florida, Yúnez River, June 21; in marshy-swampy hollow close to River, August 15, García-Díaz.

Enallagma cultellatum (Hagen)

(Pl. V, Fig. 6, 7)

Found only in Tortuguero Lake by Doctor Needham, February 10, thus adding another species record for the Island to the genus. On February 15 there were many in copula and some of them ovipositing. A female while carrying this latter process stood on a leaf of *Nymphoides humboldtianum* bending its abdomen around the margin and under the leaf on whose lower epidermis made crescent shaped slits and stuck the eggs with their micropylar end pointing towards the openings of the slits. These were placed in a semicircular arrangement. The eggs had a black conic apex surrounded by some substance which was impossible to ascertain whether it was a secretion or part of the epidermis of the leaf. While the female was ovipositing, the male kept hold on her, standing out in the air. Some nymphs were transforming and specimens were collected on the stems of plants about a foot above the water. These can be easily told from the other species by the rather stout, highly chitinized, terminal spine at the end of the serrated edges of the gill plates. Some of the adults were seen standing along the sandy shore of the lake and were common. This was in contrast with conditions in August when I saw very few, being able to collect but an adult and an additional teneral one. Possibly another localized species, the male is easily distinguished by its bright yellow frons, clypeus and labrum. A young nymph from Caño Tiburones places it among the hardiest ones for reasons given under the next species.

Tortuguero Lake, Feb. 10, Needham; Feb. 15, Needham and García-Díaz; August 16, García-Díaz. Nymphs: Tortuguero Lake, Feb. 10, (cast skins) Needham; Feb. 15; Caño Tiburones, March 12, Needham and García-Díaz.

Ischnura ramburii (Selys)

The most common damselfly on the Island through the entire year, but apparently restricted to the lower levels. There are no records above the 300 feet line. They become so numerous at times that failing to find food enough for all, they resort to cannibalism.

The pairs in copula fly for long periods together, resting among plants and flying about, but not necessarily ovipositing. This is another of the hardiest Zygopterans on the Island, since I collected nymphs in the waters of Caño Tiburones which are decidedly brackish because of their connection with the sea by way of the Arecibo River.

Río Piedras, pool in Forestry Department, Feb. 7, 8, 9; Tortuguero Lake, Feb. 10; Maunabo, Feb. 11; Isabela, March 25, Needham; Río Piedras, River back of Experimental Station, Feb. 12; Tortuguero Lake, Feb. 15; Cartagena Lagoon, Feb. 23; Guánica Lagoon, Feb. 24; Florida Road, Km. 4.7, Feb. 28; Caguas, March 4; Almirante Road, Km. 6.7, March 9; Arecibo, March 13; Lake Tortuguero, March 19, 20; Palo Seco, March 21, Needham and García-Díaz; Cartagena Lagoon, August 10, García-Díaz. Nymphs: Tortuguero Lake, Feb. 15; Río Piedras, River back of the Experimental Station, Feb. 18; Cartagena Lagoon, Feb. 23; Guánica Lagoon, Feb. 25; Caño Tiburones, March 12; Tortuguero Lake, March 20, Needham and García-Díaz; Isabela, May 12; Cartagena Lagoon, August 10, October 31, García-Díaz.

Lestes forficula (Rambur)

The most common species of the Lestinae, occurring mainly along the coast but nymphs of it have been collected at Las Cruces on Road number one in a place 1461 feet high. The females may oviposit attended or not by the male. In the first case the male clings to the support while the female thrusts her ovipositor into the tissues of the weed or water plant. A female was seen ovispositing in the leaves of a sedge from 8 to 10 inches above the surface of the water. Other times they oviposit closer to the surface and gradually go down the support below the surface inserting their eggs, until nearly the whole abdomen is in the water.

Río Piedras, pool in Forestry Department, Feb. 8; Tortuguero Lake, Feb. 10; Isabela, March 25, Needham; Río Piedras, River back of the Experimental Station, Feb. 12; Tortuguero Lake, Feb. 15; Cartagena Lagoon, Feb. 23; Florida, Feb. 28; Almirante Road, Km. 6.7, March 9; Arecibo, March 13; Tortuguero Lake, March 19–20, Needham and García-Díaz. Tortuguero Lake, August 17, García-Díaz. Nymphs: Río Piedras, pool in Forestry Department, (reared), Feb. 8, Needham; Tortuguero Lake, (reared), Feb. 15; Cartagena Lagoon, (cast skins only), Feb. 23, Needham and García-Díaz.

Lestes scalaris (Gundlach)

Not common, if compared with the preceding one, on the Island. Florida, Yúnez River, Feb. 28; Almirante Road, Km. 6.7, March 9, Needham and García-Díaz.

Lestes spumarius (Selys)

The least common species of Lestes on the Island, judging from the records which are only those of Selys and an additional one of the American Museum of Natural History. No specimens were obtained even when looked for in the place last mentioned.

Protoneura capillaris (Rambur)

A single specimen of this species caught on the Island after Selys (1886) record; unluckily the date was not indicated, about 1928. Flying to lights.

Río Piedras, Hato Rey Stop 38½, García-Díaz.

Telebasis dominicanum (Selys)

This species, and the following one prefer to the open spaces the margin of the bodies of water where they are found or else among the weeds some distance from them. Adults have been collected from sea level to the 2,000 level.

Río Piedras, River back of the Experiment Station, Feb. 12; Guánica Lake, Feb. 24; Florida, Yúnez River, Feb. 28; Florida Road Km. 4.7; Caguas, Cagüitas River, March 4; Almirante Road, Km. 6.7, March 9; Arecibo, Tanamá River, March 13, Needham and García-Díaz; San Germán, River near town, April 28; Florida, swamp in hollow close to the river, August 15; Almiante Road, Km. 6.7, June 27, García-Díaz.

Telebasis vulnerata (Hagen)

(Pl. V, Figs. 8, 9)

The adults of these species have been collected in more places than the preceding one. Well distributed all over the Island with habits as indicated already. I have collected specimens above 2,000 feet level in the Luquillo Mountains in and above La Mina Recreational Area, flying in the shade along the courses of the small creeks.

No nymphs of these species have been described so far. A female specimen reared by Doctor Needham from Buena Vista Camp in Maricao is described farther on. Klots' nymph (1932) is that of *Enallagma coecum*.

La Muda, Feb. 9; Tortuguero Lake, Feb. 15; Florida, Yúnez River, Feb. 15; Río Blanco, near the power house, March 8; Arecibo, Tanamá River, March 13, Needham and Gacía-Díaz. Nymph: Maricao Forests, Camp Buena Vista, March 24, Needham and García-Díaz.

THE NYMPHS

The immature stages or nymphs of Odonata of the West Indies were for the first time thoroughly and systematically considered by Klots (1932). The majority of her supositions were later corroborated by the collecting and rearing done by Dr. James G. Needham. In a later paper, Needham and Fisher (1936) the senior author added the description of *Idiataphe* (*Ephidatia*) *cubensis*. The descriptions which are to follow will increase the number known and modify some of the previous accounts. Yet there still remain a good number of nymphs to be reared and a great deal to learn about their habits, some of which have been indicated on the preceding pages. Following the plan of previous discussions the descriptions are placed, for convenience, in alphabetical order.

ANISOPTERA

Brachymesia furcata Hagen (Supposition)

(Pl. VI, Figs. 1, 3, 5)

Length 20.9–22.8 mm.; abdomen 14.0–14.9 mm.; hind femur 6.67–7.20 mm.; width of head 5.57–5.7 mm.; of abdomen 8.0–8.5 mm.

Head two times as wide as long; greatest width accross the eyes; the latter ones bulging conspicuously, the anterior two thirds of their margins in a smooth curve which becomes rapidly straightened on the posterior third; hind angles with minute rather thickly set black spines; occiput smoothly emarginate. The meeting of the extremities of the occiput and the hind angles marked by two broad ridges which diminish in size anteriorly. Ratio of antennal segments 1:.8:1.8:1.1:1.2:1.6:1. Last antennal segment slightly constricted near its end, the following portion forming a minute bulb. Labium thin, its hinge behind the first pair of legs but not reaching the middle of the second pair; length 3.3 mm., width 3.97–4.05 mm. Margins of medial lobe and inner edge of lateral lobes smooth and beset with strong setae. These are more or less regularly spaced along the entire length of the margin of the medial lobe which shows a cluster of them at its middle point. They are nearly absent along the basal half of the margin of the lateral lobe but become very numerous towards the apex where it meets the distal margin. Labial teeth strong, serrated and with spinules varying in number from 0 on that closest to the terminal hook to 5 on some of the middle ones and decreasing in the following ones. Lateral setae 7–8, mentals 10–13.

Legs slender, the femora with no definite pattern on them but the first and second darker than the third with their distal portions lighter than the rest. The tibia of the first leg with a well marked dark brown spot midway its length, the distal end also tinged with brown. Posterior wing pad 6.76–7.2 mm. long.

Abdomen wider than the head, smooth. Dorsal hooks on segments 3–10; those on segments 6–9 strongly developed, with highly chitinized tips and broad bases. The one on segment 9 as long as segment 10 whose hook is minute if compared with the others. No definite color pattern but lighter blotches midway between the dorsal hooks and the margins. Lateral spines on segments 8 and 9, short, strongly chitinized, somewhat incurved and with short, stout setae back of them along the edge of the segments. Length of spines 0.45 mm. and 0.6–0.75 mm. respectively. Appendages short, sharp pointed; superior and inferiors equal, laterals about one half as long, measuring 1.8–1.95 mm., 0.93–1.05 mm. and 1.87–1.95 mm. respectively.

Isabela, bare lime sink hole, March 25, Dr. James G. Needham.

REMARKS

Among the material there were these six cast skins collected by Doctor Needham in a bare lime sink hole near Isabela. They were different from all other nymphs of the genera of dragonflies known to occur on the Island. The only possibility left of nymphs not collected was *Brachymesia furcata*. As indicated before there is a good series of cast skins which are believed to be *Cannacria herbida* which agree with Doctor Geijskes' description of this supposed *Brachymesia furcata*. This was pointed out by Needham and Fisher (1936). There are some differences between Doctor Geijskes' measurements and the averages of those of the six nymphs considered in this paper and shown on Table I. They could be due to the preservation or to the possibility of Doctor Geijskes' nymphs not representing the ultimate instar as he believes.

If the nymph described has been correctly placed, it will show that Doctor Needham's contention (1930) that *Brachymesia* and *Cannacria* should be kept as two different genera is the correct one. The main differences distinguishing *Brachymesia furcata* from *Cannacria herbida* are the size of the abdominal appendages and the nature of the dorsal hooks. The former are shorter and the latter broader and stronger in *furcata* than in *herbida*. These major differences are corroborated by others like the difference in the last antennal segment, the shape of the eyes, the size of the lateral spines on segments 8 and 9, the width of the abdomen, the smaller hook of *herbida* on segment 10 and other differences indicated on Table I.

TABLE 1

MEASUREMENTS OF CAST SKINS OF *B. furcata and C. herbida*

	Brachymesia furcata						*Cannacria herbida*						Averages		Geijskes' measure.
	I (a)	II	III	IV	V	VI	I (a)	II	III	IV	V	VI	*furcata*	*herbida*	
Length of body	.....(b)	21.2	22.0	20.9	22.6	.....	21.9	20.5	23.0	24.5	23.5	22.0	21.67	22.56	18.5–19.
Length of abdomen	14.0(c)	14.5	14.2	13.6	14 9	14.2	15.4	14.2	14.7	16.0	15.7	15.0	14.23	15.16	.....(f)
Length of post-wing pad	6.75	6.75	6.75	6.75/7.05	7.2	6.75	6.75	6.45	6.6	6.6	6.67	6.6	6.82	6.61	6.5
Width of head	.....	5.55	5.70	5.7	5.7	.....	5.25	5.17	5.85	6.0	5.7	5.7	5.66	5.61	6.0
Width of abdomen	8.0	8.5	8.50	8.5	8.0	8.2	7.35	7.2	7.35	7.48	7.7	7.35	8.28	7.4	6.0
Labium:															
Length	.....	3.3	3.30	3.3	3.3	.....	3.82	3.75	4.2	4.27	4.27	4.12	3.3	4.07	.....
Width	.....	4.05	3.97	4.05	4.05	4 05	4.27	4.12	4.57	4.68	4.72	4.50	4.03	4.47	4.5–5.0
Lateral setae	.....	8	8	7	7	8 / 7	8	8	9 / 10	10	10	10	7–8	8–10	10
Mental setae	.....	10	10 / 13(e)	10 / 11	12 / 10	10 / 11	8 / 10	8	13	14 / 13	13	13	10–13	8–14	12–13
Setae on labial teeth	.....	2.4	1–5	1–5	1–5	0–4	1–3	1–3	1–3	1–2	1–3	1–3	0.5	1–3	2–5
Abdominal appendages															
Superior	1.95	1 87	1.8	1.83	1.87	1.9	3.0	3.0	2.85	2.85	2.85	2.85	1.87	2.9	.92
Lateral	.937	1.05	.97	.937	1.05	.975	1.05	.975	.975	1.05	1.05	1.05	.986	1.02	.80
Inferior	1.95	1.87	1.87	1.87	1.95	1.95	3.0	3.0	2.85	2.85	2.85	2.85	1.91	2.9	.96
Dorsal hooks of abdomen (d)	3–9	3–9	3–9	3–9	3–9	3–9	3–9	3–9	3–9	3–9	3–9	3–9	3–9	3–9	3–9
Spine on 8th segment	.45	.45	.45	.45	.45	.45	.63	.75	.45	.73	.63	.63	.45	.636	.28
Spine on 9th segment	.75	.63	.67	.60	.60	.60	1.12	1.2	.70	.90	.90	.82	.64	.94	.80
Length of 10th segment	.45	.45	.45	.45	.52	.45	.52	.525	.45	.52	.48	.45	.46	.49	.....
Length of femora:															
I	3.52	3.75	3.60	3.67	3.75	3.75	3.30	3.15	3.3	3.48	3.3	3.37	3.67	3.31	3.6
II	4.80	4.95	5.02	5.1	5.10	5.10	4.23	4.20	4.27	4.40	4.2	4.2	5.01	4.25	4.4
III	6.67	6.75	7.05	7.05	7.05	6.75	6.37	6.22	6.07	6.30	6.22	6.15	6.91	6.22	5.5

(a) The Roman numbers stand for the individual cast skins considered. All those of *B. furcata* came from a bare lime sink hole in Isabela, March 25. Under *Cannacria* I was obtained on the same date and place before mentioned. II, V and VI from Cartagena Lagoon, February 24 and August 20; III and IV from Cabo Rojo, February 24.
(b) Head missing or so broken that it could not be accurately measured.
(c) All measurements in millimeters.
(d) The tenth segment bears an additional very small hook in both species.
(e) The corresponding left and right having different numbers or unequal in length.
(f) Not given.

Coryphaeschna adnexa (Hagen)

(Pl. V, Fig. 4; Pl. VI, Fig. 7)

Length 41.5 mm.; abdomen 28.25 mm.

Large head, greatest width across the eyes 8 mm.; the latter large and rounded, their most proximal slightly sinuated margin 1.6 mm. from the occipital margin, measured from the greatest depth of the sinuation. Occiput emarginate, its proximal mid-point to a corresponding one on the vertex margin 1.4 mm., its width 5.25 mm. across. Maximum length across the head, back of the proximal margin of the eyes 6.25 mm. Ratio of the antennal segments: 1:1.5:2:1:1.5:1.5:1. The labium measures 7 mm. in length and 5 mm. wide; sides from hinge out more or less parallel for about 4 mm. where they broaden out to attain the maximum width of 5 mm. Very small setae along the finely serrated edges starting a little below the place where the broadening begins where there is besides the ridge of spinules a few of the latter on the inner surface of the labium; somewhat flattened along the margins where breadth is largest. Distal margin of medial lobe rather convex rising .5 mm. above horizontal line between bases of lateral lobes. A cleft .2 mm. deep and .15 mm. wide in the middle with two chitinized rounded teeth about .1 mm. from the edge of the cleft rising about .03 mm. above the margin. Hairs along the margin rising as high as the two teeth close to cleft. Lateral lobes with their inner lower margin denticulated beyond the curved proximal end, the small teeth increasing in size until they reach the large chitinized tooth at the distal end of the inner margin on the lower end of the nearly squarely truncate distal margin of the lateral lobe. This outer distal margin is also denticulated, but the teeth are small and compare only with those at the proximal end of the ventral margin of the lateral lobes; the large ventral tooth is about ⅓ the length of the truncate distal margin. Very small setae along the middorsal line of the movable hooks.

The legs with a few hairs on them; possibly some of the latter even lost during dryness, but by no means are they hairy. Measurements of femur, tibia, and tarsus as follows: I 3.6:4.25:2; II 5.1:4.75:2; III 6:6:2.5. Posterior wing pads 8.75 mm.

Abdomen elongate, widest at the sixth segment measuring 7.3 mm. Spines on segments 6, 7, 8, 9 having a length of .25; .6; .75; and .5 respectively. Lateral margin of spine bearing segments serrate with fine setae in the notches. Gonapophyses on 8th segment 2.75 mm. long, reaching the hind border of segment nine; those on this latter segment 2 mm. long reaching beyond the hind margin. Lateral appendages 3.75 mm. long, more or less rounded and ending in a strongly chitinized sharp point; as long as the superior which is rounded at the tip. Inferior appendages the same length of lateral reaching a fraction of a millimeter beyond the superior, triquetral in shape, incurved tips chitinized but not as heavily as laterals.

Almirante Road, near Vega Baja, Km. 6.7, March 9, Dr. James G. Needham.

REMARKS

The preceeding description is based on a cast skin supposed to represent the last larval instar because it was dry and on a bulrush. A very thin mud film covered the surface hiding all possible color patterns.

A number of similar nymphs were obtained in Tortuguero Lake together with those of *Anax*. They are easily told from these latter ones, when alive, because they have white eyes, as well as by their abdominal appendages.

None of the living nymphs collected had attained the size of the described cast skin, but undoubtedly are the same species. The younger nymphs have a tendency to be darker in color than the older ones. Antennal segments 3 and 4 are brown in color as well as the distal end of the terminal one. The labia of the younger ones may show smaller additional teeth between the cleft and the two larger teeth mentioned in the description. The color pattern on the legs is variable also from completely paternless ones, through some of their femora marked with three rings and a brown or black spot about ⅔ distant from the proximal end of the femora. These dots are the ones to hold most consistently throughout. The abdomen has no definite color pattern, but in the middle size nymphs there may appear on the sides two diagonally placed brown spots, most easily seen and occurring more frequently, on segments 5–8 although the anterior ones may show them also. A black dot on the ventral surface of the inferior appendages, close to the chitinized tip and separated from this by a less chitinized and equal to or slightly larger than the black spot itself.

Klots (1932) suggests the possibility of another species besides *C. adnexa;* since, as stated by her, this is not certain I have assumed this nymph to be the latter.[1]

ZYGOPTERA

Argiallagma minutum (Selys)

(Pl. IV; Pl. V, Figs. 1, 3; Pl. VI, Fig. 2)

Length 9 mm. + 4 mm. gills, abdomen 5.75 mm.

Head flattened, hind angles rounded with easily seen, sparsely placed spines. Antennal segments 1 and 2 with dark brown spots on their inner margins, close to the joint, also on distal outer margin of second segment. Proximal fourth of the third brown, the rest of the antenna with no markings. Ratio of antennal segments 1:1.1:2.5:1.8:1.1:.9:.7. Widest distance across the eyes 2.7

[1] See note at end. (page 85.)

mm. Labium with four mental and seven lateral setae. Distal margin of mentum more or less even, but beset with very minute teeth-like spines which give it the appearance of being finely denticulated. Inner margin of lateral lobe finely serrated; distal inner fixed tooth small and sharply incurved, notch between this and central distal lobe rather shallow and only half as wide as deep. Central terminal lobe squarely truncate with external third showing minute spines on border. Inner extreme close to fixed tooth, pointed.

Femur of first leg with two diffuse brown rings and proximal end tinged with the same color; the second with similar markings but deeper in color; on the third the pigment is not so heavy, but the rings may be easily seen. Tibiae with no definite rings, but brownish in color. Femur, tibiae and tarsi as follows: I 1.5 mm.; 1.5 mm.; 0.75 mm.; II 1.9 mm.; 2.0 mm.; 0.75 mm.; III 2.4 mm.; 2.5 mm.; 1.00 mm. Posterior wing pad 2.9 mm.

Dorsal surface of abdominal segments brown, mottled with numerous, small dots lighter in color. Middorsal area of segments with no dots on it and lighter in color than the rest, increasing in width from proximal margin of fifth segment and reaching its maximum on segment 10. About the middle of the segments 7, 8 and 9 and on the sides of the light middorsal areas, dark brown dots. Similar but fainter dots about ⅔ of the segment on 5 and 6. Lateral keels with spines. Female gonapophyses on 8 and 9, reaching beyond the distal margin of segment 10. The one on the 8th is the longest and that of the 9th with tips highly chitinized. Gills, lateral ones lanceolate, tapering to a point; more or less pigmented throughout with scattered larger brown dots. Heavier and larger pigmented areas on outer margins of distal half tending to form irregular bands. Tracheal branches pinnately arranged, being more numerous in upper half above central main trunk, than in lower area, pigmented and scarcely branched. Marginal spines about one-half the length of the gill.

Almirante Road, near Vega Baja, Km. 6.7, March 9, Needham and García-Díaz.

REMARKS

The description is based on a single specimen obtained in the same place where a series of adults were collected at the same time. One of the legs was cleared and showed the characteristic long spines of the genus.

Ceratura capreola (Hagen) (Supposition)

(Pl. V, Figs. 2, 5)

Length 9.5 mm. + 3.8–4.3 mm. gills; abdomen 6.1 mm.

Hind margins of head standing out more than usual with many spines easily seen. Greatest width across the eyes 3.3 mm. Segments one and two of the antenna brown in color, the rest with a very faintly tinge on their proximal ends. Ratio of the antennal segments 1:1.5:2:1.7:1.2:.9:.5. Labium

strong and large with one mental and six lateral setae. Distal margin slightly crenated with minute spines in crenulations close to base of lateral lobes, which becomes teeth-like as they approach to the center. Lateral lobes with straight smooth inner margin; the distal central margin between the fixed tooth and the movable hook slanting rapidly from the former to the base of the latter, slightly crenulated and having a few minute spinules on its central length.

Femora with dark colored proximal ends and two dark brown rings showing better on the first two than on the hind one. Tibiae with very fine hairs on their outer surfaces, more numerous than usual. The femur, tibia and tarsus measuring: I 1.6 mm.; 2.0 mm.; 0.8 mm.; II 2.25 mm.; 2.4 mm.; 1.1 mm.; III 2.75 mm.; 3.0 mm.; 1.2 mm.

Abdomen cylindrical; a light middorsal area on each segment, largest on 9 and 10. The rest of the segments dark brown in color with numerous setae, but no strong spines. Lateral keels conspicuous on segments 2–7, without spines, the distal ends of those on 2–5 white in color. Distal margins of segments 5–9 with dull white marks. Male ganopophyses reaching the middle of segment 10. Gills with practically no branches in the proximal third, those beyond, not greatly branched, pigmented and running more or less parallel to the margins, but rearward. Sides of gill gradually widening out for about half the distance, when they widen suddenly becoming abruptly to a point at the tip. Main trachea pigmented and a little pigment throughout the entire gill, with rounded, irregularly scattered, patches along the margins. Marginal spines of middle gill about one half the length of the gill with fine setae between the spines.

Río Piedras River, south of the Agricultural Experimental Station, March 18 Needham and García-Díaz.

REMARKS

Four nymphs with the setal formula given were collected. One of them is too young and the other three are too old to show the venation.

Klots (1932) has described a nymph collected by Doctor Needham at Wismar, British Guiana, April 13, 1930. These nymphs differ in many details from the one described by Doctor Klots, but is only a supposition which is justified mainly on the basis of the size. The nymphs which I take for fully mature, because of the stage of development of the wing pads, are too small for any of the other species on the Island with the exception of *Argiallagma minutum* from which are easily distinguished by the setal formula. The measurements given are based on one of the nymphs since of the other three one is too young and the other two had their abdomen elongated due to poor preservation.

Enallagma civile (Hagen)

REMARKS

The nymph of this species was described by Doctor Needham and Cockerell (1903). Its absence in the collection struck me, more so when adults were collected and seen in many places where nymphs apparently were absent. Upon examining the venation of the wing pads of some nymphs believed to be *Ischnura ramburii* I found that M_1—M_2 arose in many of them between the 4th and 5th postnodals instead of between the 3rd and 4th. This suggested the possibility of some of these nymphs being those of *Enallagma civile*. This supposition was backed to a certain extent by some of those nymphs having three mental setae, other with three mentals and sometimes a rudimentary fourth one, while a few others would have four mental and lastly a rudimentary fifth one. These facts made it impossible to certainly distinguish *Enallagma civile* from *Isachnura ramburii*, since all other characters, including the gills, seem to intergrade and be similar in the two species. The lengths of the second and third antenal segment are somewhat reliable in distinguishing them. In *Enallagma* the third segment is fully one and a half times longer than the second while in *Ischnura* it is slightly longer, but never as in the first case. The Puerto Rican species, as it often happens with corresponding northern and southern ones, seems to be smaller in size than that described by Needham and Cookerell. Were it not for this, it could be easily told apart because none of Puerto Rican species attain the size of the original description. A reared series of both species will be the only possible final criteria.

Enallagma coecum (Hagen)

Length 12–12.5 mm. + 4.3 mm.–4.5 mm. gills; abdomen 8–8.3 mm.

Dorsal surface of head back of posterior margin of eyes dotted with brown spots which are the bases of small spines; hind angles smooth and but with a few spines on margin. Widest distance across the eyes 3.1 mm. First and second antennal segments brown, proximal and distal ends of third segment tinged with brown with a lighter middle area; segments 4, 5 and 6 with proximal ends tinged with brown also. Ratio of antennal segments 1:1:1.5:.9:.5:.3:.2. Labium with one mental and three lateral setae. Distal margin of mentum irregularly serrated for about one-fourth its distance from the base of lateral lobe, from there on to the center more regularly serrated with minute spinules set in the notches. Inner margin of lateral lobe uneven: deep notch between terminal hook and central distal portion between the latter and movable hook. Distal margin of this central lobe broken into 3–5 irregular teeth.

Femora of all legs with an apical brown ring, rest of the legs without markings. Inner proximal end of tibiae with a chitinized spine-like outer mar-

gin. Distal end of tarsus darker in color than the rest. Femora, tibia and tarsus: I 1.55 mm.; 1.9 mm.; .9 mm.; II 2.1 mm.; 2.2 mm.; 1 mm.; III 2.7 mm.; 2.75 mm.; 1.15 mm.; Posterior wing pads 3.9 mm.

Abdomen covered with numerous spines. A middorsal thin line which broadens posteriorly on segment 8, 9 and 10, where the clear area covers most of the dorsal surface. An area, darker than the rest of the segment, on the sides of the clear line, widest in segments 6 and 7 and hardly noticeable on the sides of clear area on segment 10. On the distal middorsal margins of segments 4–9 two brown spots separated by the clear central line. On the same margins and half way between dorsal dots and lateral keel a small dark dot on segments 4, 5, and 6. Lateral keels well developed on segments 2–8 with easily seen spines on the entire keel. Gonapophyses of female on 8 and 9, reaching distal end of segment 10, those of male as far as the middle of segment 10. Gills jointed, marginal spines extending to the joint, the rest of the margin with very final setae. A main central trachea with few rather simple lateral branches most numerous beyond the joint, on proximal half some pigmented tracheal branches. Pigment on proximal half close to central trachea; on distal half covering a broader area in irregular patches, sometimes tending to form 2 or 3 cross bands. The tips of unbroken gills end in a point but in the majority this tip breaks and the gill ends in an acute angle.

Adjuntas, March 28, Needham and García-Díaz.

REMARKS

Klots (1932) in discussing the species *E. coecum* and *E. cardenium* after a most careful and exact consideration of the male appendages as well as indicating other differences in the adults did not feel like making them two different species, but the second a subspecies of the first. The rearing of a male and female specimen by Doctor Needham and myself and a comparison of these nymphs with the description of the one by Byers (1930), tend to make a valid species for *Enallagma cardenium*. The differences between the described nymphs as well as those of the adults indicated by Klots. it is believed, substantiate this view.

The nymphs upon which Klots based her description as *Telebasis dominicanum* were, I think, not fully developed which may account for discrepancies in both descriptions.

Enallagma cultellatum (Hagen)

(Pl. V, Figs. 6, 7)

Length 11.5 mm. + 5 mm. gills; abdomen 7.5–8 mm.

Head much wider than long; eyes standing out laterally from hind margins with the emargination where the former and the latter meet deeper than usual; hind margins slightly spinulose and not smoothly rounded, but tending to form a wide angle at their extreme outer points as they curve into proximal

margin of eyes. First segment of the antenna and two-thirds of the second brown in color; the rest with no markings. Ratio of antennal segments: 1:0.8:1.6:1.0:0.6:0.4:0.3. Labium with 3 + 1 mental and 5 lateral setae. Central distal portion of mental lobe smoothly rounded with its edge crenulated, with small denticles set in the crenulations, most easily seen in central half of the entire margin. Inner margin of lateral lobe minutely crenulated. A deep broad, slightly deeper than broad, notch between the terminal fixed tooth and the distal central portion of the lateral lobe; this latter one broken into three well defined teeth followed by an irregular broken surface and a straight outermost side; the first tooth about twice the size of the following one.

Legs slender, the femora with distal or apical brown rings, their proximal ends also brown; tibiae with a proximal incomplete brown ring showing best on the ventral surface, the rest of the legs with no color pattern. Measurements of femur, tibia and tarsus: I 1.5 mm.; 1.8 mm.; 0.8 mm.; II 2.0 mm.; 2.1 mm.; 0.9 mm.; III 2.6 mm.; 2.7 mm.; 1.00 mm.

Abdomen with lateral keels strongly developed on segments 2–8, spiny, ending at their distal end in two strong chitinized spines in segments 2–7; segment 8 with only one distal lateral spine; segment 9 without a well marked lateral keel, but showing a single strong terminal spine in place corresponding to preceding ones. On middorsal line of segments 4–9, on distal margin, two spines larger and more strongly chitinized than the rest, on middorsal surface of segment 2 near its proximal margin a close tuft of setae; a smaller and similar tuft on segment one. Gonapophyses of female on 8 and 9 not reaching but close to distal margin of segment 10. Gills jointed about half-way their length, with pigmented branched tracheae. Marginal spines to the joint terminating in one thicker than the other with a strongly chitinized base.

Tortuguero Lake, February 14, 15, Needham and García-Díaz.

REMARKS

A reared male and a few cast skins served as a basis for the description. No other nymphs were collected. The measurements are mainly from the cast skins. The color pattern of the gills of the living nymphs may very from the one given herein.

A very young nymph from Caño Tiburones shows on its gills the characteristic spine of the marginal ones. The gills have many transparent areas alternating with incomplete, irregular transverse, light brown areas. Lateral branches few, branched and pigmented.

Telebasis vulnerata (Hagen)

(Pl. V, Figs. 8, 9)

Length 12.5 mm. + 4.5 mm. gills; abdomen 7.5 mm.

Head with large conspicuous eyes, posterior margins smoothly rounded and slightly spinulose. Ratio of antennal segments 1:1.5:2.6:1.8:1.1:.8:.5 The second segment with a small distal outwardly placed dark spot. The rest with no markings. Extremely fine setae on papillae on the middle of segment three

as well as on its distal end where they are more numerous. Similar papillae and setae on distal ends of segments 4–7. Labium reaching the middle coxae; three mental setae with many minute ones scattered about; six easily seen lateral ones with an additional weaker and smaller one close to the base of lateral lobe. Distal margin of mentum smooth with teeth-like spinules separated by a distance at least equal to the size of the spinules. Central distal margin of lateral lobe somewhat truncate with a slight notch close to fixed tooth and on its outer two thirds bearing spinules similar to those of distal margin of mentum.

Femora with two brown rings separated by three nearly equal light areas. The first brown ring on the first femora not so clearly marked at the others. Extreme proximal end of the tibiae tinged with brown as well as distal end of femora. Distal end of tibiae light in color followed by a brown ring, rest of tibia clear. Femora, tibiae and tarsi as follows: I 2.0 mm.; 2.4 mm.; tarsi missing; II 2.6 mm.; 2.7 mm.; 1.1 mm.; III 3.3 mm.; 3.4 mm.; 1.4 mm.; Posterior wing pads 4 mm.

Abdomen with well developed spines on the lateral keels of segments 4, 5, 6, 7 and 8 though less numerous on the first and last of those mentioned. The distal margins of these segments decidedly brown with light clear areas. Two brown broken lines close to the lateral keels. Dorsal surface of some segments sparsely covered with short spines most numerous in segments 6, 7, and 8. The tenth segment decidedly circular, the distal margin fringed with short, strong chitinized spines. Female gonapophyses on 8th and 9th segments nearly reaching distal margin of segment 10. Gills about three and a half times as long as wide; dorsal marginal spines of middle gill, one half its length, on the spaces between the spines very fine setae varying in number, but most numerous on distal ones; the main trachea pigmented with light and dark places, lateral branches not very numerous, but strong and more branched towards the basal portion of the gill, pigmented. Basal half of gill with little pigment when compared with distal one where it is irregularly scattered in darker blotches with lighter areas between.

Maricao Forest Reserve, Camp Buena Vista, March 24, Needham.

REMARKS

A single reared female specimen, on the cast skin of which is based the description. No more nymphs collected. As indicated before I think the nymph described under this name by Klots (1932) is *E. coecum*.

TABLE II. THE ALTITUDINAL DISTRIBUTION OF ODONATA: NYMPHS AND ADULTS

Species	Nymphs			Adults		
	No. of Sta.	Min. Alt.	Max. Alt.	No. of Sta.	Min. Alt.	Max. Alt.
ANISOPTERA						
1. Acanthagyna nervosa	*1	80	.....	.....	.....	.....
2. Aeschna cornigera	*1	2350+	.....	1	1968	.....
3. Anax amazili	1	80	.....	.....	.....	.....
4. Anax junius	5	**0	1968	9	0**	1896
5. Cannacria herbida	*1	20	.....	11	0	300
6. Brachymesia furcata	*1	164	.....	1	300	.....
7. Coryphaeschna adnexa	3	0	164	3	0	300
8. Dythemis rufinervis	5	80	2000+	18	0	1896+
9. Erythemis plebeja	.....	.....	.....	6	0	500
10. Erythrodiplax berenice naeva	.....	.....	.....	1	.....	60
11. Erythrodiplax c. justiniana	*1	.....	164	12	0	1896
12. Erythrodiplax minuscula	.....	.....	.....	2	20	80
13. Erythrodiplax umbrata	2	0	80	17	0	1050
14. Gynacantha trifida	.....	.....	.....	.....	.....	.....
15. Idiataphe cubensis	1	.....	0	1	0	.....
16. Lepthemis vesiculosa	3	0	300	18	0	1050
17. Macrothemis celeno	4	100	1300	18	0	2000+
18. Misthyria marcella	1	.....	300	4	0	86
19. Micrathyria aequalis	.....	.....	.....	1	20	.....
20. Micrathyria didyma didyma	.....	.....	.....	.....	.....	.....
21. Micrathyria dissocians	*1	.....	300	8	20	233
22. Micrathyria hageni	.....	.....	.....	.....	.....	.....
23. Orthemis ferruginea	4	80	1300	18	0	1980
24. Pantala flavescens	.....	.....	.....	8	0	1500
25. Perithemis domitia	2	80	164	3	20	164
26. Scapanea frontalis	3	500	1968	10	16	2000+
27 Tramea abdominalis	1	.....	20	17	0	1896
28. Tramea binotata	.....	.....	.....	4	0	500
29. Tramea onusta	.....	.....	.....	8	0	104
ZYGOPTERA						
30. Anomalagrion hastatum	2	80	.....	11	0	500
31. Argiallagma minutum	*1	.....	.....	2	.....	.....
32. Ceratura capreola	0	.....	.....	3	.....	500
33. Enallagma civile	0	.....	.....	11	0	1896
34. Enallagma coecum	10	80	1050	23	0	2000+
35. Enallagma cultellatum	1	0	.....	1	0	.....
36. Ischnura ramburii	3	0	300	18	0	300
37. Leptobasis vacillans	.....	.....	.....	.....	.....	.....
38. Lestes forficula	8	0	1461	10	0	500
39. Lestes scalaris	.....	.....	.....	2	0	500
40. Lestes spumarius	.....	.....	.....	1	.....	17
41. Protoneura capillaris	.....	.....	.....	1	.....	80
42. Telebasis dominicanum	.....	.....	.....	9	17	1968
43. Telebasis vulnerata	1	.....	2350	15	16	2000

* Nymphs designated by supposition.

** Sea level.

TABLE III. BIRDS FEEDING ON ODONATA AS SHOWN BY STOMACH CONTENTS

	Bowdish, 1902				Danforth, 1926				Wetmore, 1915; 1927			
	Anisoptera		Zygoptera		Anisoptera		Zygoptera		Anisoptera		Zygoptera	
	Nymphs	Adults	Nymphs	Adults	Nymphs	Adults	Nymphs	Adults	Nymphs	Adults	Nymphs	Adults
1. Butorides virescens cubanus (Oberholser) (Cuban Green Heron, Martinete)									some	1		several
2. Butorides virescens maculatus (Boddaert) (West Indian Green Heron, Martinete)					32. %			10 %				
3. Comsothlypis americana usneae (Brewster) (Northern Parula Warbler, (Reinita)					2.6%							
4. Crotophaga ani (Linnaeus) (Ani, Judio)					2.6%			1.4%		.5%		
5. Dendroica petechia bartholemica Sundeval (Porto Rican Yellow Warbler, Reinita)										1.3%		
6. Egretta candidissima candidissima (Gmelin) (Snowy Egret, Garza blanca)							4 %	15 %	2			
7. Erismatura alleni (Danforth) (Allen's Ruddy Duck, Chorizo)					4.5%							
8. Falco columbarius columbarius (Linnaeus) (Pigeon Hawk, Gavilán, Lechuza)						73 %	12 %					
9. Florida coerula coerulescens (Latham) (Little Blue Heron, Garza Azul)									2			
10. Gelochelidon nilotica (Gmelin) (Gull-billed Tern, Gaviota)					4%							
11. Helodromas solitarius solitarius (Wilson) (Solitary Sandpiper, Putilla)									50%			
12. Herodias Egretta (Gmelin) (Egret, Garzón blanco)										3		
13. Hirundo rustica erythrogaster (Boddaert) (Barn Swallow, Golondrina)								5.3%				
14. Hydranassa tricolor ruficelis (Goose) (Louisiana Heron, Garza de vientre blanco) •					5%							
15. Hydrochelidon nigra surinamensis (Gmelin) (Black Tern, Gaviota prieta)						3.8%		2%				
16. Holoquiscalus niger brachypterus (Cassin) (Porto Rican Crackle, Chango)						1.3%						
17. Marila affinis (Eyton) (Lesser Scaup Duck, Pato silvestre)									69%			
18. Melanerpes portoricensis (Daudin) (Porto Rican Woodpecker. Carpintero)		1										
19. Mimus polyglottos orpheus (Linnaeus) (Jamaican Mockingbird, Ruiseñor)		1										
20. Oxyechus vociferus rubidus Riley (Antillean Killdeer, Playero)										3.9%		
21. Podilymbus podiceps antillarum (Bangs) (Antillean Piedbilled, Zaramago)					8%				2	1.3%		
22. Progne dominicensis (Gmelin) (Caribbean Martin, Golondrina de Iglesis)										8%		
23. Seirus novaboracensis novaboracensis (Gmelin) (Northern Water Thrush, Pizpita)								10				
24. Seirus motacilla (Vieillot) Louisiana Water Thrush, Pizpita chica)										1		
25. Totanus melanoleucus (Gmelin) Greater Yellow Legs, Playonito)					65.3%							

eatchus adults

SUMMARY OF TABLE III.

	Bowdish, 1902	Danforth, 1926	Wetmore, 1916; 1927
Total number of species of birds reported feeding on insects...	30	53	69
Species feeding on odonates...	2	15	12
Percentages of species preying on odonates...	6.6	28.3	17.4

NOTE

While the preceding pages were in press specimens were collected which alter some records and points of view taken at the time the work was done.

Acanthagyna nervosa Rambur

Specimens were collected in Tortuguero Lake, west end Oct. 31. The end of the lake was completely dry. While collecting, late in the afternoon, it became quite dark when a specimen was seen. Presently other specimen appeared and seven were collected. They fly close to the ground, from 12 to 18 inches, among the clumps of grasses. Once seen it is most probable to capture them, even if missed once or twice, because they keep flying slowly around.

The collecting of these specimens in this place questions the supposition of the numph described under *Coryphaeschna adnexa*. The adults were collected exactly on the same place where the nymphs believed to be the same as that dscribed were collected. Could these nymphs be those of *Acanthagyna nervosa* and not those of *Coryphaeschna adnexa?*

Gynacantha trifida (Rambur)

Specimens of this species were captured for the first time in Ameryjul, a small farm on the Trujillo Alto road Km. 1.2, Oct. 9, at dusk, close to a small creek east of the main road. Another specimen was caught in the same place Dec. 8 at 5:00 P. M. Two other specimens were obtained about four kilometer from the place: one at home, Stop 38½ Hato Rey, Nov. 18, which flew into the bath room and another found in a room of the Stahl building in the University by Mr. R. Córdova Marqués, Dec. 20.

The adults appear late in this afternoon. They are very rapid flyers making it nearly impossible to capture them. They do not fly usually in the open but keep "nosing" into the higher plants and bushes. Their somber colors make it some times impossible to distinguish them and only their flight makes them visible. I have never seen one standing still. Now and then they dart up into the open space above, reaching an altitude of 30 feet or more.

The collection of the specimen at Stop 38½, Hato Rey, verifies the statement made on page 55. The presence of adults in the mentioned area questions, in view of the statements made under *Acanthagyna* in this note, Klots' (1932) assumption about the nymph believed by her to be that of *Acanthagyna*.

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SEASONAL DISTRIBUTION OF ODONATA

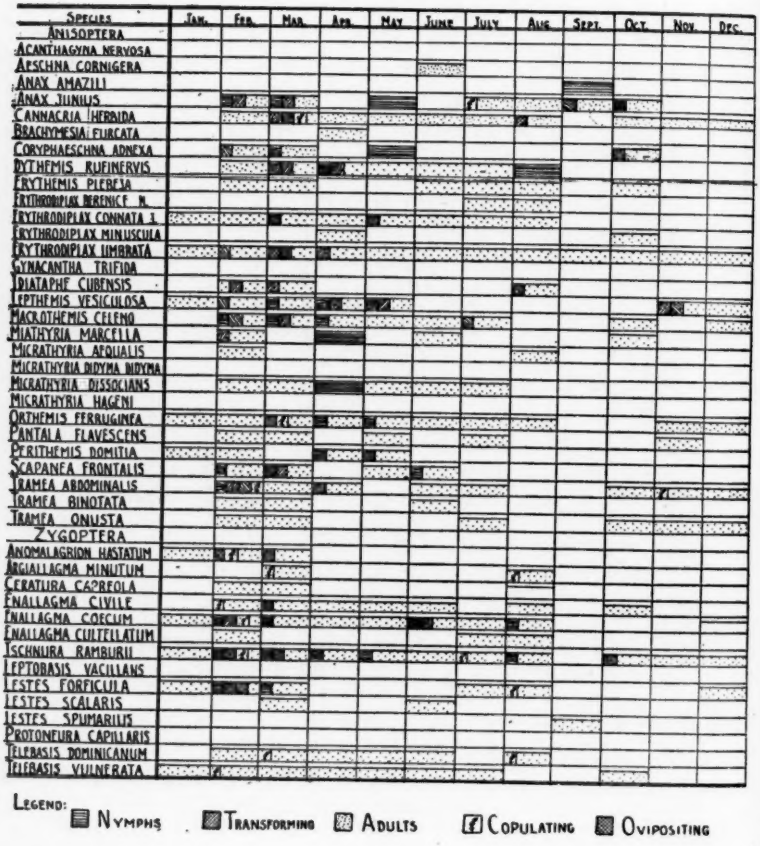
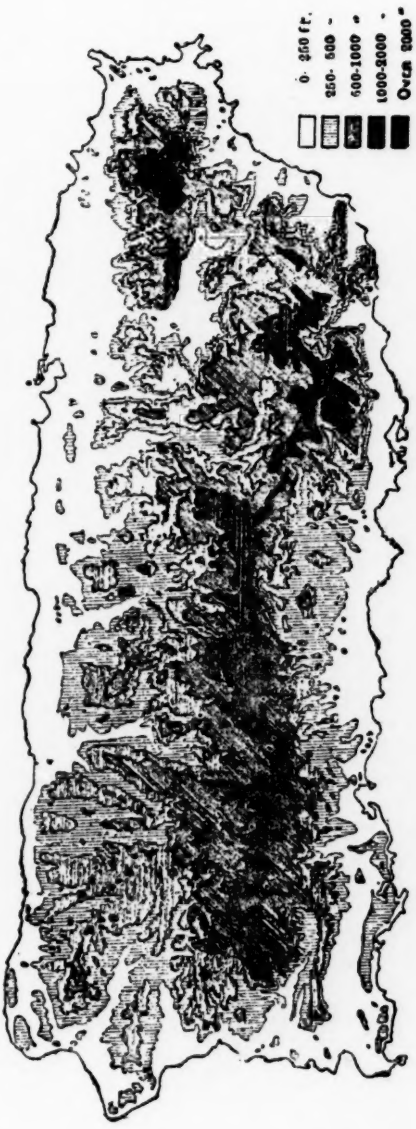


FIG. 1



PHYSIOGRAPHIC MAP OF PUERTO RICO

FIG. 2

LOCALITIES IN PUERTO RICO WHERE ANISOPTERA HAVE BEEN COLLECTED
LEGEND: ● ADULTS ○ NYMPHS AND ADULTS ⊕ NYMPHS

FIG. 3

LOCALITIES IN PUERTO RICO WHERE ZYGOPTERA HAVE BEEN COLLECTED
LEGEND
ADULTS
NYMPHS AND ADULTS
NYMPHS

FIG. 4

Appendix A

The following is a record of the material collected in Puerto Rico together with the one discussed on the preceding pages. As stated before, I feel a deep and great obligation for the specialists who most kindly have made the determinations. Dr. C. P. Alexander determined the Tipulidae; Dr. C. Betten the Trichoptera—this order has been worked only to genera due to lack of time on my part to take advantage of Doctor Betten's help; Dr. W. T. M. Forbes the Lepidoptera; Dr. R. Matheson the Culicidae; Dr. P. N. Musgrave the Dryopidae; Dr. A. J. Mutchler the Dytiscidae, Gyrinidae and Hydrophilidae; Dr. J. G. Needham the Odonata; and Dr. J. R. Traver the Ephemeroptera. Dr. O. A. Johannsen is working the rest of the Nemocera, and Dr. H. B. Hungerford the aquatic Hemiptera. I have still some material which will be submitted, in the near future, to other specialists.

COLEOPTERA

Dryopidae: det. Dr. P. N. Musgrave.

1. *Cylloepus danforthi* Musgrave.
2. *Neoelmis gracilis* Musgrave.
3. *Phanocerus* hubbardi** Schaeffer.

Dytiscidae: det. Dr. A. J. Mutchler.

4. *Bidesus** sp.
5. *Copelatus posticatus* F.
6. *Hydrocanthus iricolor* Say.
7. *Laccophilus bifasciatus* Chevrolat.
8. *Laccophilus proximus* Say.
9. *Pachydrus brevis* Sharp.
10. *Pachydrus globosus* Aube.
11. *Rhantus* calidus** F.
12. *Thermonectes basillaris* Harris.
13. *Thermonectes circumscriptus* Latreille.
14. *Thermonectes margineguttatus* Aube.

Gyrinidae: det. Dr. A. J. Mutchler.

15. *Dineutes metallicus* Aube.
16. *Dineutes longimanus portoricensis* Ochs.
17. *Gyrinus rugifer* Regimbart.

Hydrophilidae: det. Dr. A. J. Mutchler.

18. *Berosus guadaloupensis* Fleut. and Salle.
19. *Berosus tesselatus* Chevrolat.
20. *Derallus* rudis** Sharp.
21. *Enochrus nebulosus* Say.
22. *Enochrus ochraceus* Melsh.
23. *Hydrophilus insularis* Chevrolat.

* New record of genus and species based on material collected.

24. *Hydrophilus ater intermedius* Jacq. Duval.
25. *Nechydrophilus* phallicus** Orohymont.
26. *Ochthebus* sp.
27. *Paracymus* subcupreus?** Say
28. *Pelosoma** sp.
29. *Phaenotypus* palmarum** Schwarz.
30. *Tropisternus collaris* F.
31. *Tropisternus lateralis* F.

DIPTERA

Culicidae: **det. Dr. R. Matheson.**

32. *Chaoborus* festivus** D. & S.
33. *Culex antillum-magnorum* Dyar.

Tipulidae: **det. Dr. C. P. Alexander.**

34. *Dolichopeza (Megistomastixo) acutiloba*** Alex.
35. *Dolichopeza (Megistomastix) obtusiloba*** Alex.
36. *Erioptera (Mesocyphona) caloptera* Say.
37. *Erioptera (Mesocyphona) portoricensis* Alex.
38. *Gonomyia (Lipophleps) bicornuta* Alex.
39. *Gonomyia (Lipophleps) monocantha*** Alex.
40. *Gonomyia (Lipophleps) orthomera*** Alex.
41. *Gonomyia (Lipophleps) pleuralis* (Will.)
42. *Gonomyia (Lipophleps) subterminalis* Alex.
43. *Gnophomyice diazi*** Alex.
44. *Helius (Helius) albitarsis* O. S.
45. *Hexaloma (Eriocera) trifasciata* (Boder).
46. *Limonia (Geranomyia) antillarum* Alex.
47. *Limonia (Dicranomyia) brevivana torrida* Alex.
48. *Limonia (Neolimnobia) diva* Schiner).
49. *Limonia (Dicranomivia) distans* O. S.
50. *Limonia (Rhipidia) domestica* O. S.
51. *Limonia (Rhipidia) tetraleuca*** Alex.
52. *Limonia (Geranomyia) subrecisa* Alex.
53. *Polymera (Polymera) geniculata* Alex.
54. *Shannonomyia leonardi* Alex.
55. *Shannonomyia triangularis* (Alex.)
56. *Toxorhina (Toxorhina) fragilis* Lw.
57. *Trentepholia (Paramongoma) niveitarsis* Alex.

EPHEMEROPTERA: det. Dr. J. R. Traver.

Baetidae.

58. *Baetis* garcianus*** Traver.
59. *Baetis* spp.
60. *Borinquena** carmencita*** Traver.
61. *Borinquena contradicens*** Traver.
62. *Caenis** sp.
63. *Callibaetis completa* Banks.
64. *Cloeodes** maculipes*** Traver.

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* New record of genus or species based on material collected.

** New genera and species based on material collected.

65. *Cloeodes portoricense*** Traver.
66. *Cloeodes consignatum*** Traver.
67. *Cloeodes* sp.
68. *Neohagenulus*** *julio*** Traver.
69. *Neohagenulus tinctus*** Traver.
70. *Neohagenulus* sp.

LEPIDOPTERA: det. Dr. W. T. M. Forbes.

*Arctiidae.****
Progona pallida Moschler.
*Cosmopterigidae.****
Eriphia? sp.
*Phaloniidae.****
Phalonia sp.
Pyralidae.
71. *Argyractis sumptuosalis* Moschler.
72. *Nymphula rugosalis* Muschler.
*Tineidae.****
Achanodes sp.
Homostinea? tischeriella? Walsingham.
Mea incudella Forbes.
Protodarcia sp.
*Tortricidae.****
Balbis excitana? Moschler.
Epiblema sp.

TRICHOPTERA: det. Dr. C. Betten.

Helicopsychinae.
73. *Helicopsyche* sp.
Hydropsychidae.
74. *Smicridea** sp.
*Hydroptilidae.**
75. *Hydroptila* sp.
76. *Neotrichia** sp.
77. New genera.**
78. *Oxyethira** sp.
Leptoceridae.
79. *Setodes**sp.
Philopotamidae.
80. *Chimarra albomaculata* Kolbe.
81. *Chimarra* sp.*
*Polycentropidae**
82. New genus.**
*Psychomyidae.**
83. *Lype** sp.
*Rhyacophilidae.**
84. *Atopsyche** sp.

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* New record of genus or species based on material collected.
*** Not aquatic.

EXPLANATION OF PLATES

PLATE IV

Argiallagma minutum (Selys)

PLATE V

1. *Argiallagma minutum*, labium.
2. *Ceratura capreola*, labium.
3. *Argiallagma minutum*, gill.
4. *Coryphaeschna adnexa*, labium.
5. *Ceratura capreola*, gill.
6. *Enallagma cultellatum*, gill.
7. *Enallagma cultellatum*, labium.
8. *Telebasis vulnerata*, labium.
9. *Telebasis vulnerata*, gill.

PLATE VI

1. *Brachymesia furcata*, part of abdomen with dorsal hooks and caudal appendages.
2. *Cannacria herbida*, part of abdomen, lateral, with dorsal hooks and caudal appendages.
3. *Brachymesia furcata*, part of the abdomen, lateral, with dorsal hooks and caudal appendages.
4. *Cannacria herbida*, antenna.
5. *Brachymesia furcata*, antenna.
6. *Cannacria herbida*, part of abdomen, with dorsal hooks and caudal appendages.
7. *Coryphaeschna adnexa*, caudal appandages.
8. *Anax amazili*, caudal appendages.

PLATE VII

Wings of:

1. *Cannacria herbida.*
2. *Argiallagma minutum.*
3. *Idiataphe cubensis.*

PLATE IV

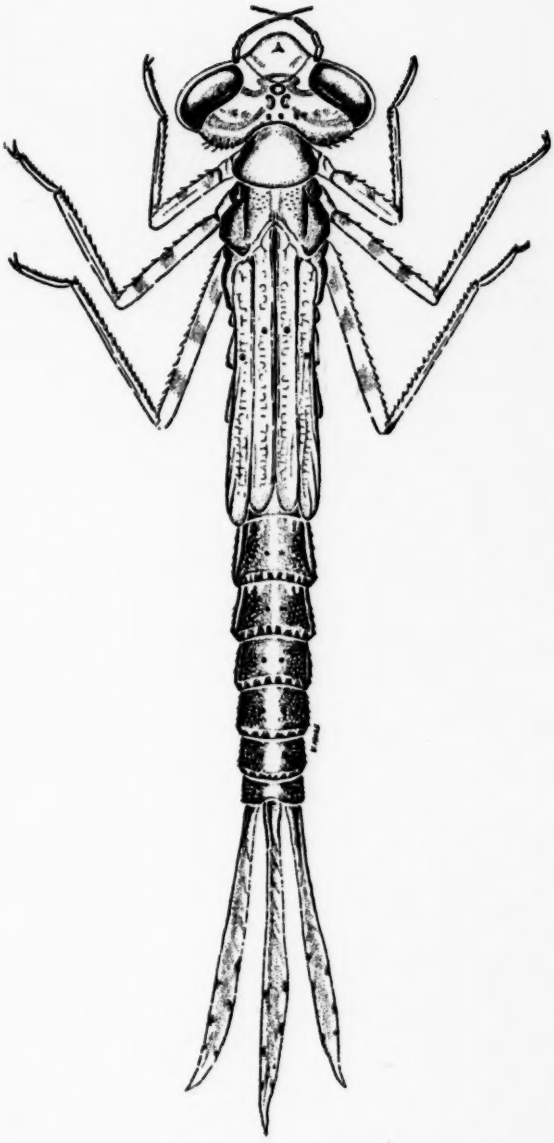

PLATE V

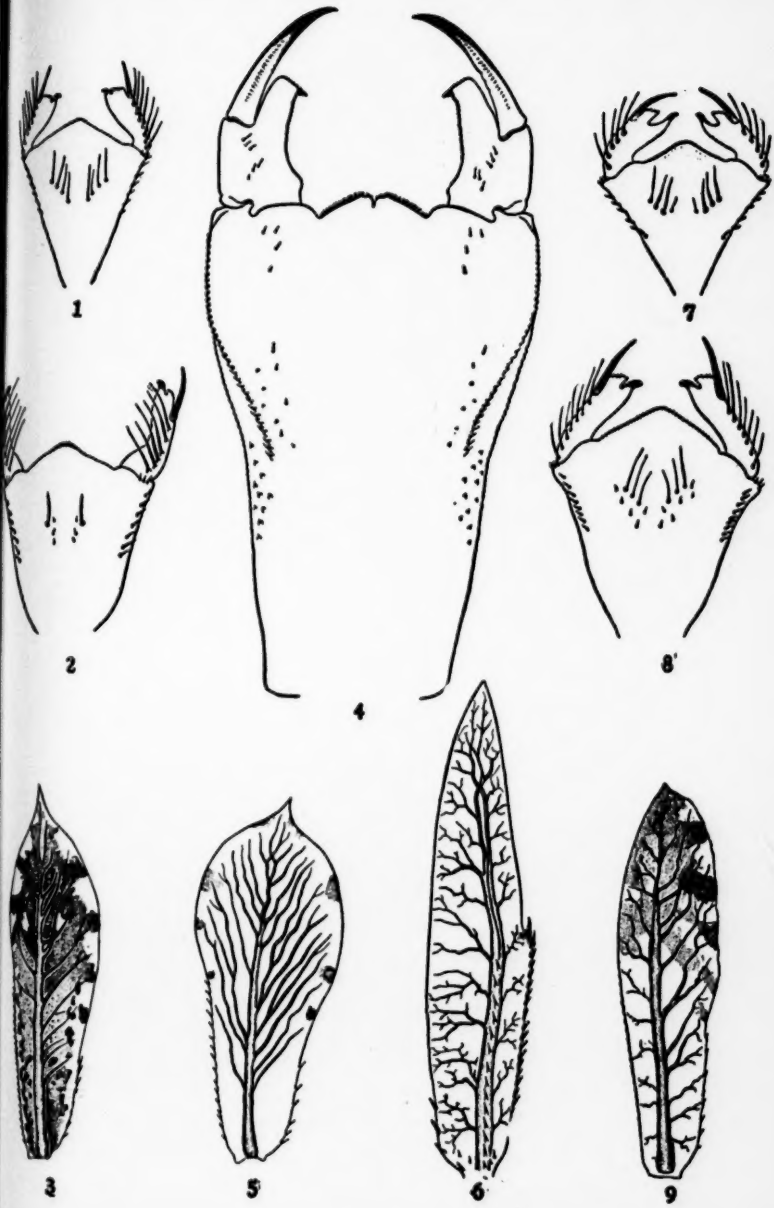

PLATE VI

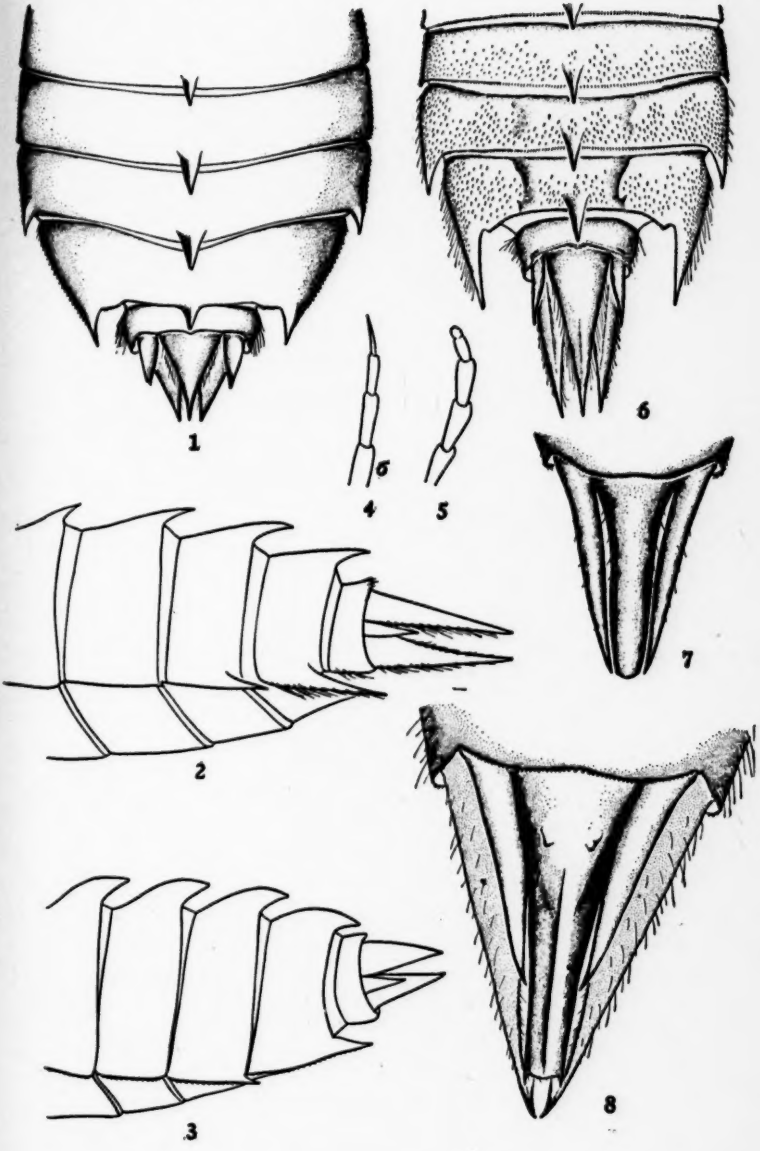
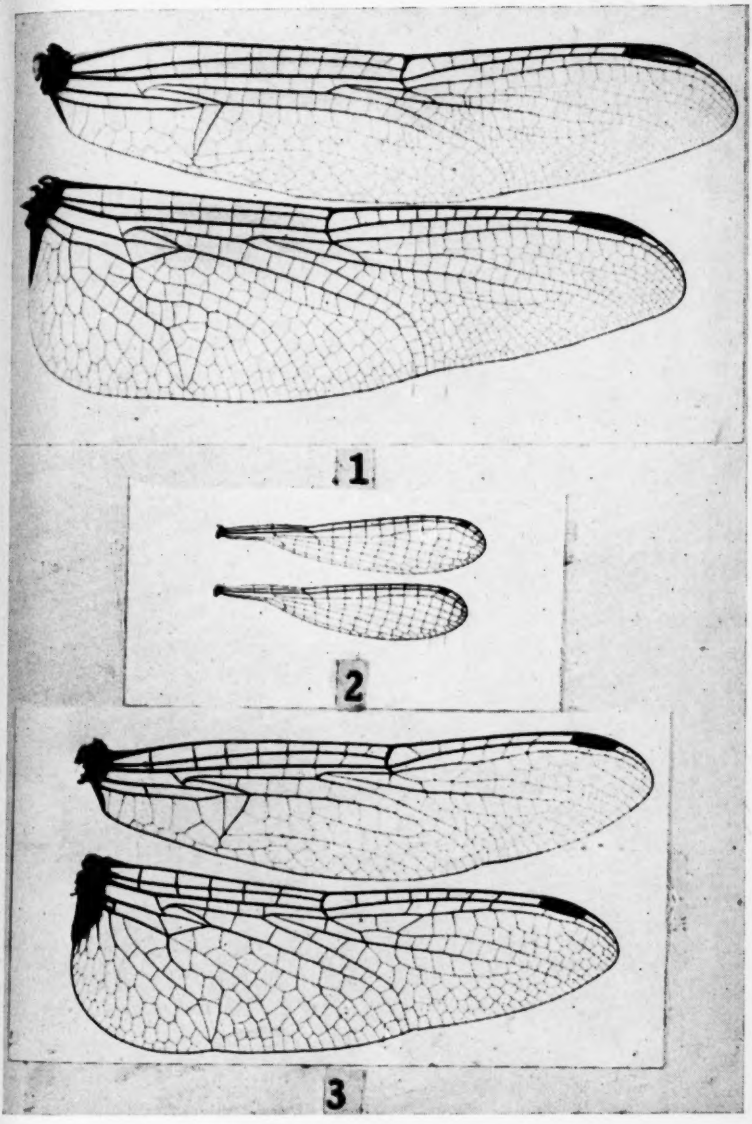
PLATE VII